Engineering News

VOLUME 71 APRIL 9, 1914 NUMBER 15

Excavation and Foundation Work for the Kensico Dam

By Wilson Fitch Smith*

SYNOPSIS—A masonry dam 307 ft. high, 1843 ft. long, containing 900,000 cu.yd. of masonry will store 29 billion gallons of water near the lower end of the Catskill Aqueduct, New York City additional water-supply. Expansion joints 80 ft. c. to c., drainage wells, inspection galleries, and an architectural treatment of the downstream face of the dam are among its special features. The contract price was nearly $8,000,000. Steam shovels were used for excavating work and cableways for handling the excavated material and much of the contractor's plant. Guy and stiff-leg derricks were used to complete the excavation and to place masonry. The contractor's plant represents an investment of more than $1,000,000 and is operated largely by electrical current. During seven months of 1913, a total of 316,000 cu.yd. and in September, 53,242 cu.yd. of concrete and concrete blocks were placed in the dam. Progress on construction to date indicates that the dam will be completed long in advance of the contract date, which was about 1920.

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The Kensico Dam, now under construction by New York City, for a storage reservoir in the valley of the Bronx River, three miles north of White Plains, is an important feature of the Catskill water-supply system. It takes rank among the notable masonry dams of the world not only on account of being one of the largest, but also because of the methods of construction which enabled over 300,000 cu.yd. of masonry to be placed in the dam during the working season of 1913. It is be-

Fig. 1. Excavation for Kensico Dam, Looking East from Tail Towers, July 30, 1912

(The excavation has uncovered the bedrock in the bottom of the valley, and while one steam shovel is removing the surface rock down to a suitable foundation, two steam shovels are attacking the preglacial gorge. The spoil is removed over the railway through a cut in the old dam on the right. The wooden flume to carry the local drainage past the excavation is on the farther side of the valley for a distance each side of the excavation; this is carried on piles. The steel buildings on the east hill are the carpenter and machine shops and storehouse. The building at the left is the concrete transformer house and power house. The top of the new dam will be 5 ft. above the base of the cable towers.)

lieved that, with the exception of the Panama locks, this is an accomplishment that has not been excelled in any other single masonry structure.

General Description

The Kensico Dam (Figs. 2 and 3) is of gravity type, 1843 ft. long at the coping, with a maximum height of 307 ft. from the lowest point in the foundation to the surface of the roadway on top. It is 28 ft. thick at the top and 233 ft. thick at the thickest part of the base. The profile is the heaviest and most conservative of any of the larger modern dams.

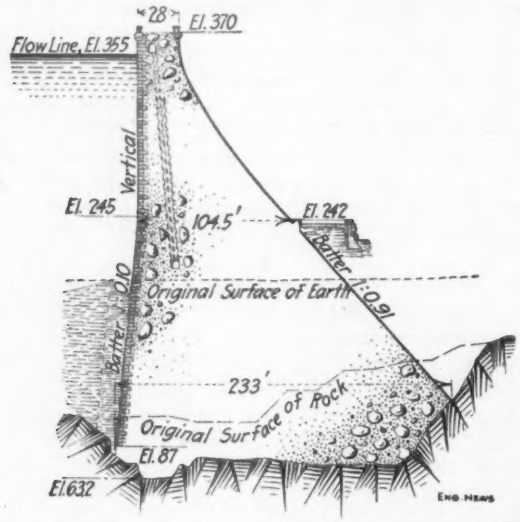


Fig. 2. Maximum Cross-Section of Kensico Dam

It is built of cyclopean masonry, with concrete blocks on the upstream face and cut-stone masonry on the exposed portion of the downstream face. Expansion joints, designed to prevent the irregular cracking of the face due to the shrinkage of the masonry, are placed about 80 ft. apart, dividing the dam into sections, which greatly facilitate construction. These expansion joints and the copper water stops in them, the drainage wells at frequent intervals near the upstream face of the dam, and inspection galleries the entire length of the dam, are some of the special features of the design. The structure will contain about 900,000 cu.yd. of masonry.

The dam forms a storage reservoir (Fig. 4) which will cover 2218 acres at Elev. 355 ft. above sea level, with a maximum depth of 155 ft., an average depth of 53 ft., and an available capacity of 29,000,000,000 gal. The reservoir will afford a large reserve storage near the city, being only 14 miles above the distributing reservoir at Hillview, just north of the city line, and 77 miles from the Ashokan Reservoir, which is the main impounding reservoir in the Catskills.

The Catskill Aqueduct, with a maximum daily capacity of 500,000,000 gal., will discharge into the upper end of the Kensico Reservoir, about four miles north of the Kensico Dam, over a weir 216 ft. long in the center of the aqueduct. The hydraulic grade line of the aqueduct at this point is at the same elevation as the normal surface elevation of the reservoir. The water will be drawn from the reservoir through a short tunnel on the west side of the reservoir about a mile north of the dam. Large gate chambers at both ends of this tunnel control the flow of water into the aqueduct. A reinforced-concrete aqueduct connects the influent works with the upper effluent gate chamber so that water may be passed directly to the city if necessary. It is expected to maintain the Kensico Reservoir full and draw upon it only in the event of closing down the aqueduct to the north for cleaning or repairs. The effluent works include a large aëration basin, screen chamber, and reinforced-concrete Venturi meter with throat casting 8¾ ft. in diameter.

Because of its size and location so near the city, and at the northern terminus of the Bronx Valley Parkway, the dam was deemed worthy of more serious architectural treatment than would be accorded to a similar structure in a more remote location. The face of the dam will rise from a level terrace 1030 ft. long and 30 ft. wide, which will be 15 ft. above the general level of the plaza in front of the dam. From the ends of the terrace the ground will be graded symmetrically up both hillsides to the top and ends of the dam. The vast exposed face, over 1800 ft. long at the cornice, 1000 ft. at the base and 130 ft. high, will be divided into upright panels by bands of heavy rustication 15 ft. wide. The bands are about 80 ft. apart and coincide with each expansion joint, thus expressing an essential feature of the design of the dam. Between the rustications the panels will be filled with roughly squared stone masonry, the whole surmounted by a heavy cornice. The ends of the dam and terrace will be marked by loggias, and in front of the terrace will be a large pool flanked by fountains. The approach to the dam will be developed by a formal landscape treatment in keeping with the dignity and importance of the structure, and will form an interesting entrance to the reservoir area, embracing over 4000 acres of great natural beauty, which, in time, may become an extension of the metropolitan park system of New York City.

Construction Work

The contract for the construction of the dam and reservoir, exclusive of the aqueduct work, was awarded to Rodgers, Rodgers & Hagerty, in December, 1909, and was assigned to H. S. Kerbaugh, Inc., in September, 1910. The amount of the contract, based on the bid prices and the preliminary estimate of quantities, is $7,953,050.

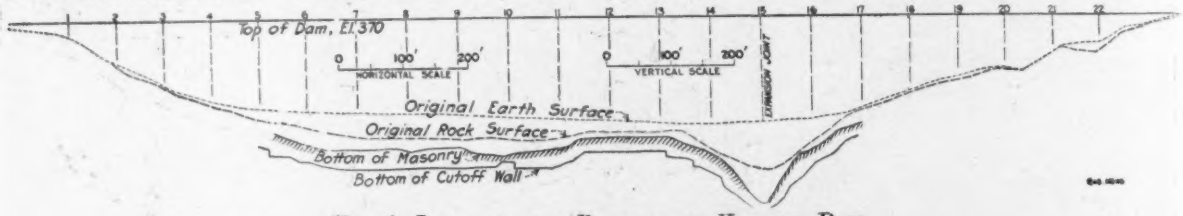


Fig. 3. Longitudinal Profiles of Kensico Dam

(All of the profiles, excepting the cutoff, are for the entire width of the dam.)

As the Kensico Dam is located a few hundred feet upstream from the old dam, which developed the local

...ershed of 22 sq.mi., it was necessary to draw off the ...d reservoir, and before this could be done a substitute ...eservoir had to be developed further up the valley in ...rder to maintain the supply to a portion of the Bronx ...orough. Therefore, the first work under the contract ...as the construction of two temporary reservoirs (Fig. ...) within the limits of the new reservoir, and the relo...ation of about five miles of highways, involving three ...oncrete bridges, one a reinforced-concrete arch bridge ...f five spans averaging 127 ft. each. The years of 1910 and 1911 were devoted to this preliminary work, and excavation for the dam was begun on Sept. 22, 1911.

The side hills of the Bronx Valley at the dam site rise about 170 ft. above the floor of the valley, the lowest point of which is at Elev. 200 ft. The east hill is of Fordham gneiss and the west hill of Manhattan schist, with very light cover. Between these two formations is a stratum of Inwood limestone about 400 ft. thick. Geologically, the valley is an eroded limb of a simple fold, with a strike nearly north and south, or at right angles to the line of the dam, and an average dip to the west of 55°. The floor of the valley at the dam site is about 900 ft. wide, with from 10 to 30 ft. of modified drift overlying the rock bed, some of the material being so fine that 96% passed a No. 50 sieve. Borings revealed a pre-glacial gorge in the vicinity of the contact between the gneiss and the limestone, about 150 ft. wide at the top and about 120 ft. deep below the valley floor. At a depth of about 30 ft., and again near the surface of the disintegrated rock in the bottom of the gorge, thin layers of coarse sand and gravel were found. The bottom of the gorge still held about 40 ft. of disintegrated rock that had not been removed by the glacial scour (Figs. 5 and 6).

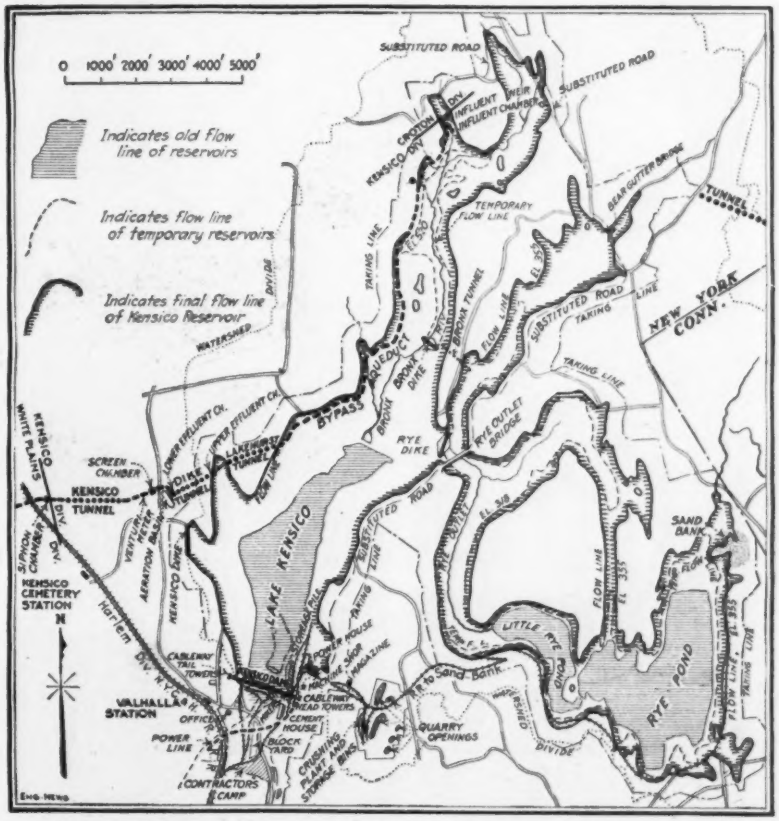


FIG. 4. MAP OF KENSICO DAM AND RESERVOIR, SHOWING LAYOUT OF CONTRACTOR'S PLANT

EXCAVATION—The excavation for the dam was started with three steam shovels (Fig. 1), the material being removed in 8-yd. cars of standard gage and was disposed of in the low ground below the dam, the grading of the plaza and approach taking care of practically all of the excavation from the dam site, which amounted to 600,000 cu.yd.

As the excavation reached the lower level of the very fine sand, some difficulty was experienced in supporting the shovels. The material was so fine that it held the water, and although the material would stand in a vertical face 10 ft. high in front of the shovel, when it was subjected to vibration under the shovel it would soften up so that recourse was finally had to floating the shovels on rafts made of sections of three 14x14-in. timbers 24 ft. long, bolted together. These sections of raft were taken up, moved ahead and placed by traveling cranes operating on the muck tracks. After the rock was reached, it was drilled to depths of 10 to 15 ft. and removed by the shovels.

By July, 1912, the excavation over the broad area of the bottom had so far progressed that two shovels were concentrated on the gorge (Fig. 5; also see Figs. 7 and 8 for character of the gorge excavation and rock). The excavated material from here was hauled in four-car trains up an incline on the north slope. The excavation of the west hill proceeded simultaneously by guy derricks. After the removal of an average depth of 20 ft. of rock over the broad area, rock of satisfactory soundness was reached and the remaining excavation, including barring and wedging, was removed by traveling cranes and guy derricks. In October, 1912, a depth of 60 ft. below the surface was reached in the gorge, and the width had so narrowed that one shovel was removed from the pit.

At this time the fine, water-bearing material gave considerable trouble on the north slope. The saturated material stood for a while, but as the excavation deepened the material began to flow and, aggravated by a heavy rainfall, assumed discouraging proportions. Excavated rock was dumped on the slope, and after some 14,000 cu.yd. had been placed the slope was held and no further trouble resulted.

After the sliding bank rendered the incline useless, the material from the gorge was raised in 8-yd. skips by the cableways and dumped into cars on the high ground on the east hill side. On Mar. 26, 1913, the remaining shovel was removed from the gorge and the excavation pushed by hand (see Fig. 9 for condition of excavation about this time). On Apr. 23, 1913, the excavation in the gorge was so far completed that the first masonry was

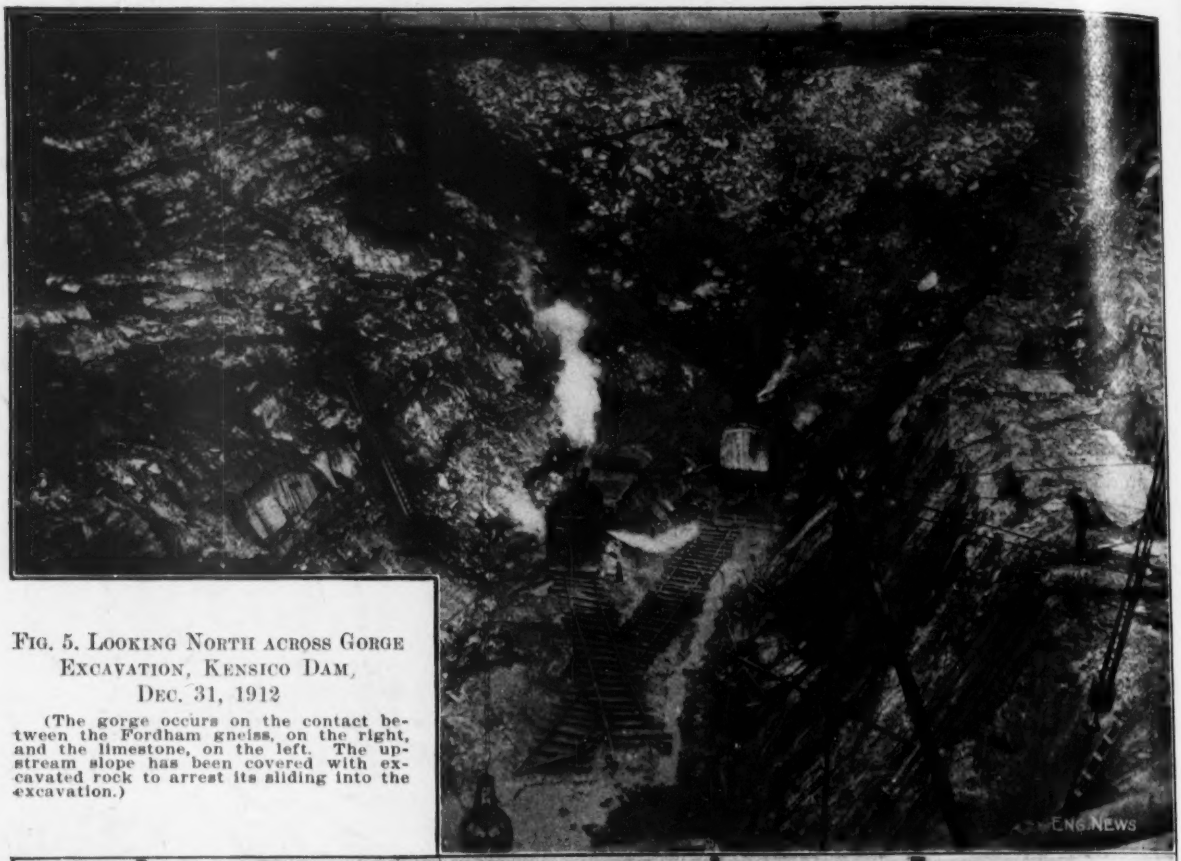


FIG. 5. LOOKING NORTH ACROSS GORGE EXCAVATION, KENSICO DAM, DEC. 31, 1912

(The gorge occurs on the contact between the Fordham gneiss, on the right, and the limestone, on the left. The upstream slope has been covered with excavated rock to arrest its sliding into the excavation.)

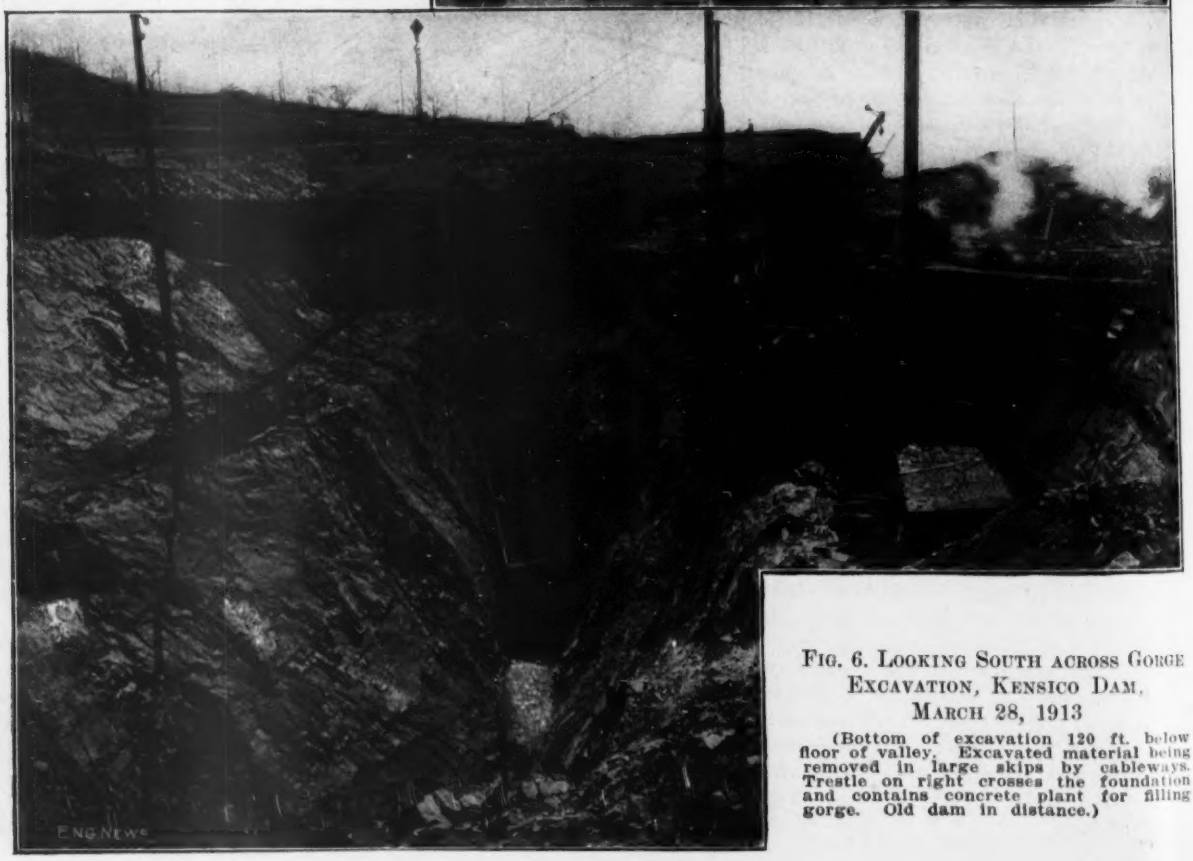


FIG. 6. LOOKING SOUTH ACROSS GORGE EXCAVATION, KENSICO DAM, MARCH 28, 1913

(Bottom of excavation 120 ft. below floor of valley. Excavated material being removed in large skips by cableways. Trestle on right crosses the foundation and contains concrete plant for filling gorge. Old dam in distance.)

FIG. 7. CONTACT OF LIMESTONE AND GNEISS IN GORGE OF KENSICO DAM; APRIL 22, 1913

(At Elevation +75, 125 ft. below floor of valley. Note the careful cleaning of the rock surface, every loose fragment being removed.)

FIG. 8. EXCAVATION OF CUTOFF TRENCH RUNNING UP EAST SIDE OF GORGE, KENSICO DAM, LOOKING SOUTHEAST, MAY 14, 1913

(Vertical holes 25 ft. deep, spaced about 6 in. apart, were drilled on the sides of the trench. The middle two of the four bench holes are loaded and shot first.
Cyclopean masonry in bottom of gorge at right. The centrifugal pump is lifting drainage water from sump to flume. The cement shed shows in right background and the 36-in. Rye pipeline, supported on piers, in left background).

placed. In the meantime, the excavation of the cutoff trench was prosecuted. This was a trench 20 ft. wide and from 20 to 30 ft. deep under the upstream face of the dam for its entire length except at the ends above Elev. 300.

The excavation revealed sound rock for the foundations everywhere very close to the elevations assumed from the core and the diamond-drill borings. These borings gave especially close results in delimiting the gorge and demonstrated the wisdom of careful preliminary explorations. Satisfactory foundations were found at all points. Even the limestone presented no unusual problems. Although of a similar formation to that under the new Croton Dam, it is of more sound character and such erosions as were found were of only superficial importance.

Bedding seams more or less open occurred in all three rock formations, but the cutoff trench was carried below the point where these could have any significance. Moreover, a number of drill holes crossing these seams at varying depths up to 25 ft. were made and grout pipes inserted. After a sufficient depth of masonry had been placed, careful tests with colored water under 100 lb. pressure failed to reveal any but satisfactory conditions. Subsequent grouting to refusal, under pressures up to 100 lb., has produced a tight and satisfactory foundation.

CONTRACTOR'S PLANT—During 1912, the contractor was also assembling plant and developing the quarries. (See map, Fig. 4, for location.) Two cableways of 1860-ft. span across the dam site on movable timber towers 125 ft. high, were installed early. These are used principally for aiding in the excavation and handling the plant on the dam. Eight guy derricks with 85-ft. booms and 16 stiff-leg derricks with 57-ft. booms, mounted on travelers, are used for completing the excavation and placing masonry. These are equipped with 75-hp. double-speed electric hoists. In fact, the plant is largely operated by electricity, which is supplied by the New York Edison Co. The current is brought from their Yonkers plant over a high-tension transmission line which follows the aqueduct right-of-way. The current, at 45,000 volts, is transformed at the site of the work to 2200, at which tension it is conducted to the field transformers and is used to operate rock drills, pumps, hoists,

cableways, the rock-crushing plant and compressors.

The contractor acquired a favorable quarry site about a mile east of the dam, which contains an almost unlimited amount of gneissoid granite of suitable quality for all purposes. A rock-crushing plant of 175 tons per hour capacity was erected. It includes a 60x84-in. jaw crusher, one of the largest ever built, an intermediate jaw crusher, 36x72-in., a 30-ft. rotary screen, 60-in. rolls for rejections, and bins with a capacity of 8000 cu.yd.

A large deposit of sand suitable for use without screening was located on city land on the east side of the reservoir. This is loaded by steam shovel into standard 60,000-lb. gondola cars and hauled to the mixers.

also the plant for placing the concrete in the main portion of the dam will be described in later issues.

The work is being done for New York City under the supervision of the Board of Water Supply, of which J. Waldo Smith is chief engineer and Frank E. Winsor is department engineer. Beverly R. Value is chief engineer and Geo. H. Angell is superintendent for the contractor.

Preservation of Timber by Salt has recently been noted by the U. S. Forest Service. It was found in replacing a recently burned railroad trestle along the north shore of Great Salt Lake, Utah, that the piles were sound after 43 years of service. These were of local pine and fir, but were found to have been impregnated with salt from the lake. At another point on the lake, some 18-in. piles, 29 years old, have been similarly reserved with salt which has penetrated to the center. Timbers in the Southern Pacific R.R. trestles across the lake, placed in 1902, appear as good as when driven and have been preserved above the water line by salt spray dashed upon them. The first transcontinental telegraph line, which was built before the first railroad, extended west from Salt Lake City through the then prosperous mining camps of Eureka, Austin and Virginia City. When the railroad was built the telegraph line was transferred to this right-of-way and the old poles were sawed off at the ground. A recent examination of the butts left in the ground in the salt desert near Fish Springs, Utah, showed that after the 50 years, since the poles were cut off, the butts were perfectly sound. It has been common practice in the Salt Lake Valley to preserve poles by putting about 75 lb. of salt in the ground around the butts.

FIG. 9. GENERAL VIEW OF EXCAVATION FOR KENSICO DAM, LOOKING EAST FROM FOOT OF TAIL TOWERS. MARCH 28, 1913

(Excavation nearly completed. Preparing foundation for masonry. Supply trestles at both ends of excavation and in center on west edge of gorge. One traveler being erected on concrete piers in center foreground. Cutoff trench under upstream face of dam at left; flume to carry local drainage past excavation in middle of foreground. The top of the dam will be 5 ft. above the base of the cable towers on theopposite hill. The tower, wall and embankment on right are parts of the old Kensico Dam.)

A standard-gage stone-ballasted track runs from the Harlem Division of the New York Central & Hudson R. R. through the contractor's yard, to various points on the dam site, to the quarry and sand bank about three miles beyond the quarry.

The plant equipment, representing an investment of over $1,000,000, is most complete, and no money has been spared by the contractor to develop an organization which will enable very rapid progress to be made in the construction of the dam. As a result, it is expected to anticipate the contract time for completion by several years.

The plant for the manufacture of concrete blocks and

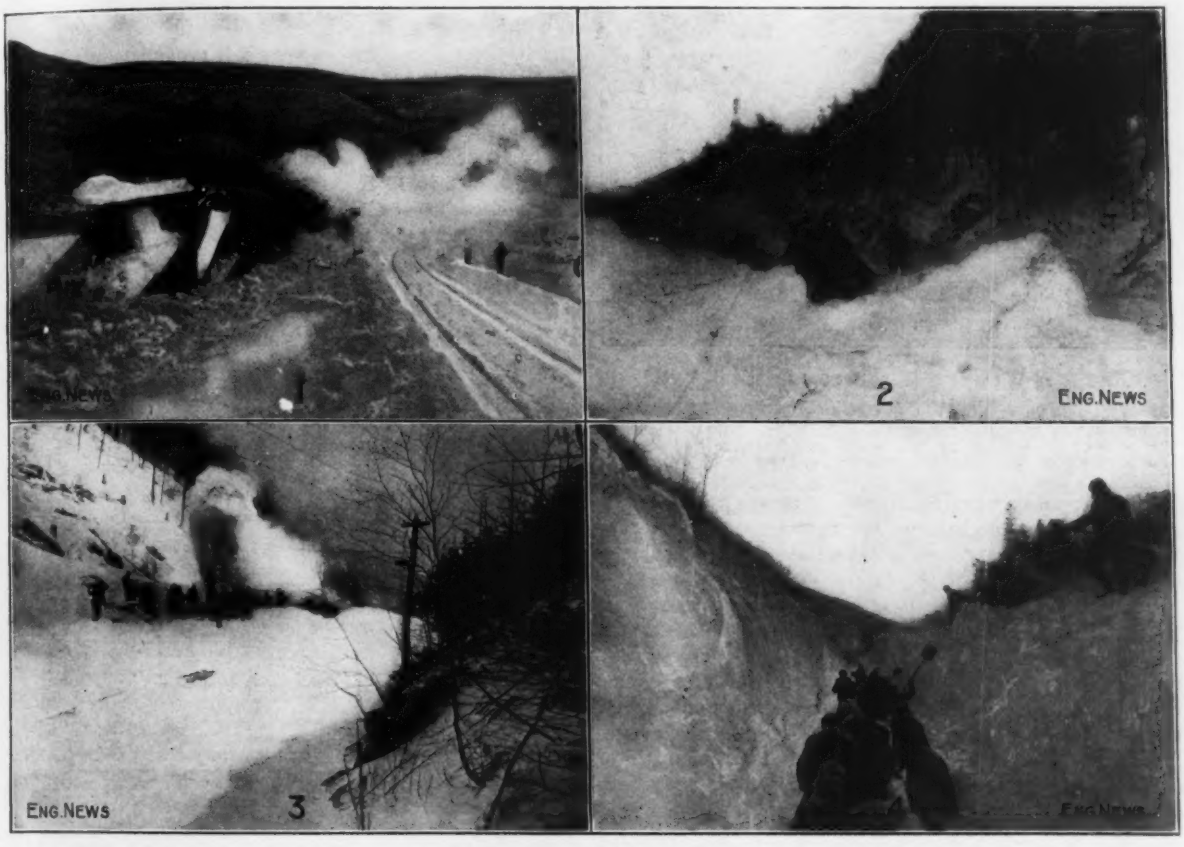
Fighting Snow on the Ulster & Delaware R.R.

The accompanying photographs represent scenes that are familiar enough along the lines of Canadian railways during the winter months, or in sections of the United States lying just south of Canada. It is rare indeed, however, to have such severe snow conditions met with so far south as southern New York. The Ulster & Delaware R.R., on which the above photographs were taken, just after the storm of March 1, runs from Kingston, on the Hudson River, into the heart of the Catskill Mountains. The place where the photographs were taken is known as Stony Clove Notch. It is so narrow that there is barely room enough for the railroad tracks and a narrow public highway which run through the gorge side by side. The gorge is located near the summit of the Catskill plateau, being at an elevation of 2170 ft. above sea level. The tracks at this point are on a 3% grade. As the photographs make clear, the wind and storm piled the snow in the gorge so deep that it buried the track nearly to the top of the locomotive stack.

Such expensive luxuries as rotary snow plows are so seldom needed in this southern latitude that the road had to be cleared with the ordinary push plow. To drive the plow through the drifts, three heavy locomotives were attached to it; but notwithstanding this, the plow was stuck five times at this point, and each time had to be shoveled out before the outfit could back up and take another run at the drift. This division of the Ulster & Delaware was completely blocked for two days, all trains being canceled.

This division is not equipped with block signals. The lower division, however, is so equipped, and the signals were put entirely out of service by the storm. The wet snow came down so rapidly and was so heavy that about half the signals were frozen fast *in the clear position* before the line wires came down; and they remained in that position until the signalmen arrived and chopped them loose. The pole line along the railway, carrying signal and telegraph wires, was built entirely new last season, and of first-class materials; but it was so completely wrecked that it had to be in large part rebuilt. The difficulty in securing linemen was so great, because of the widespread damage done to pole lines by the storm in all this region, that the work of repair was carried on very slowly, and an entire month elapsed before the block signals could be again put in service.

We are indebted to M. H. McGee, of Kingston, N. Y., for the photographs herewith reproduced, and the information concerning the storm conditions on the railway.



VIEWS IN STONY CLOVE NOTCH ON THE ULSTER & DELAWARE R.R. AFTER THE STORM OF MARCH 1

Pig-Iron Production in the United States increased from 18 million tons in 1903 to 30 million in 1912, and that of Germany from 10 million to 17½ million, while that of England remained practically stationary at about 9 million tons per year, according to statistics compiled by the Department of Commerce. From 1903 to 1908, England was first, Germany, second, and the United States, third, in the exportation of iron and steel products. Since then, Germany has pushed to the front, with England, second, and the United States, third. The exports from the United States, however, have increased more rapidly during the past ten years.

A New Walking Excavator

An excavator which is mounted upon a tractor device having a "walking" motion, instead of being mounted upon rollers or wheels, is an interesting machine which has been brought out recently and is used especially in land drainage work. The advantages claimed for this method of moving the machine are in giving a much larger bearing area than rollers, wheels, or caterpillars; and in giving only a direct pressure upon the ground, thus avoiding the tearing up and churning of soft soil by wheels or caterpillars. It requires no tracks for wheels and no skids or plankways for rollers, and thus dispenses with men required to handle such auxiliary parts. The machine can travel in any direction and can change its direction readily, turning angles or curves without any skidding. The mechanism for moving comprises few parts, which are large and substantial and not liable to wear.

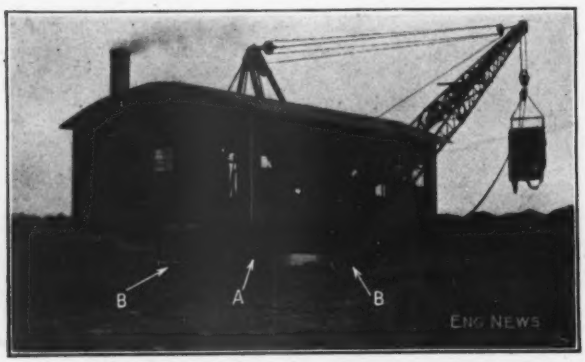


FIG. 1. A WALKING EXCAVATOR AT WORK ON A DRAINAGE DITCH

(Monighan Machine Co., Chicago, Builder. When working, the weight is carried by the solid-base turntable frame A. When moving, the weight is carried by the two shoes B B.

The excavator is of the drag-line type and is shown at work in Fig. 1, while Fig. 2 shows the details of the tractor or traveling device. The steel frame carrying the machinery and boom revolves upon a turntable or circular base which rests on the ground and forms the support of the machine when working. The bottom of this base frame is covered with steel plates, so that it provides a large bearing area. Across the upper or revolving frame extends a 9-in. shaft carrying at each end a cast-steel sector *A*, to which is pivoted a lifting beam *B*. From this beam is suspended the shoe or platform *C*, which has a steel frame shod with plank. Upon the shaft is a large spur wheel *D*, gearing with a pinion which is mounted on the shaft of the loading drum and is fitted with a jaw clutch and a band brake.

When the machine is excavating, there is no load upon the shoes, which are swung clear of the ground, the entire weight being carried by the base of the turntable. When the machine is to be moved, the pinion clutch is thrown in and the engine started, thus driving the cross-shaft. As this revolves, the sectors and beams lift the side shoes and swing them 8 ft. forward, till they rest upon the ground. The continued revolution of the shaft causes the sectors to ride or rock upon steel plates on top of the shoes, the entire weight of the machine being thus transmitted to these shoes while the machine is lifted bodily and shifted 8 ft. forward. The total advance is thus 16 ft. When the movement is completed, the sectors lift the shoes clear of the ground, and the machine is again carried upon the broad base of the turntable. The clutch is then released, and the machine resumes work.

As the shoes are carried by the revolving frame there is no skidding in turning the machine at an angle or curve. With the shoes raised clear of the ground, the machine is revolved into the desired line of direction, the shoes being then lowered and the machine advanced in this line. Thus it is readily movable in any direction, and wide ditch work can be handled with a comparatively short boom, the machine working alternately on opposite sides of the center line of the cut. The shorter boom permits of a larger bucket and greater excavating capacity. As the shoes are raised about 2 ft. from the ground, it is easy to place timbers or earth filling beneath them if required in very soft ground.

The machine shown in Fig. 1 is at work on a drainage ditch 3½ mi. long, near Wheeling, Ill., the contract involving about 100,000 yd. of excavation. The ditch is 10 ft. wide on the bottom, with side slopes of 1 : 1 and a depth of 5 to 10 ft. There is a 15-ft. berm and a spoil bank on each side for the greater part of the distance, but in some places these are on one side only. The machine has a 50-ft. boom and handles a 2½-yd. scraper bucket. Its turntable track is 17 ft. diameter. The two shoes or side platforms are 20x4 ft., each composed of two 12-in. I-beams with ⅝-in. cover-plates on top and 3-in. oak planks bolted to the bottom flanges.

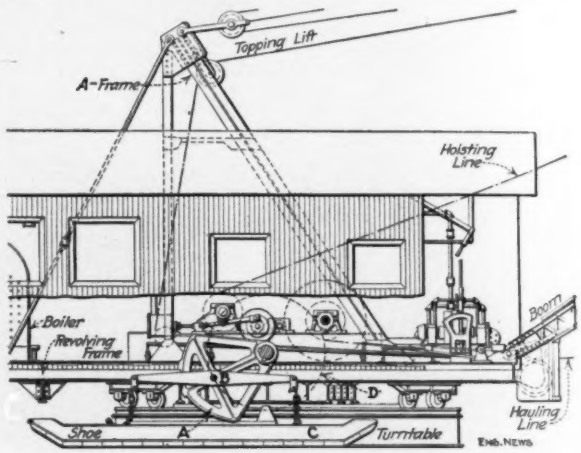


FIG. 2. TRAVELING OR WALKING MECHANISM OF THE WALKING EXCAVATOR

The main engine has two cylinders 10x10 in., and the swinging engine has cylinders 6¼x8 in. The loading and hoisting drums are 24 and 18 in. diameter, each made in three parts put together with nickel-steel bolts; the barrel is of cast-steel, grooved for the rope, and the friction and brake flanges are of so called semi-steel. The drums have bronze bushings; they are fitted with outside band-type friction clutches operated by steam-thrust cylinders, and with wide brake bands having asbestos lining. The boom drum is 12 in. diameter, operated by means of a jaw clutch. The gear ratio is 15 to 1 for the hauling or loading drum, and 3¾ to 1 for the hoisting drum. All gears are open hearth annealed steel castings, with cut teeth.

The turntable frame consists of a circular beam with four crossbeams and eight struts, all made of 18-in. I-beams. This framing is covered on the bottom with ⅜-in. steel plate, giving a bearing area of about 240 sq.ft.

The 90-lb. track rail is bolted to the top flange of the circular beam, and the cast-steel rack is bolted to the outside of the rail. The upper or revolving platform is of 12-in. I-beams, and is mounted on 18 cast-steel wheels 14 in. diameter. It is held in place by steel center castings and a king-pin, the pin being made hollow to allow of passing the feed-water pipe through it. The boom is of box-lattice construction, and is guyed from an A-frame 17½ ft. high, built of heavy angles.

The boiler is of the locomotive type, carrying 125 lb. pressure and there is a 750-gal. water tank. The weight of the machine is about 65 tons. A larger size is made, having a 24-ft. turntable, 65-ft. boom and 3½-yd. bucket; this weighs about 85 tons. The machines may be operated by gasoline engines or electric motors if required.

These "walking" drag-line excavators are built by the Monighan Machine Co., of Chicago. The tractor or walking mechanism is the invention of O. J. Martinson, secretary of the company, to whom we are indebted for information.

Timber Bulkheads and Groins for Shore Protection at Cape Henlopen Light Station, Del.*

A timber shore bulkhead, 700 ft. long, and four timber groins are under construction at Cape Henlopen Light Station, Del. The shore at this point is exposed to heavy seas and has suffered considerably from erosion. The layout of the system is shown in Fig. 1.

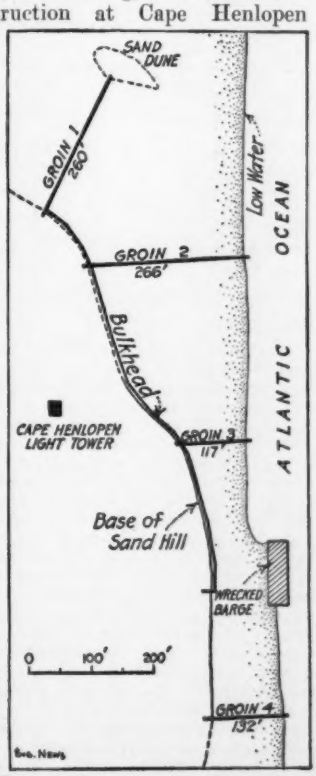


FIG. 1. LAYOUT OF BULKHEAD AND GROINS FOR SHORE PROTECTION AT CAPE HENLOPEN LIGHT STATION

The four groins, aggregating a total length of 775 ft., will be constructed of pine piling, having a diameter of not less than 6 in. at the point and 10 in. at 12 ft. from the point. The piles will be placed 4-ft. on centers in two rows and staggered. The penetration specified is 12 ft. The tops of the piling will be parallel to the slope of the beach, at an elevation of 4½ ft. above it.

Between the two rows of piles, 3x12-in. horizontal planking will be secured by 1-in. galvanized bolts. The horizontal planking will be 36 in. deep, 18 in. of which will extend into the sand beach. The ends of the planking will be secured to each other with 3x12-in. fishplates and ½-in. galvanized boat spikes.

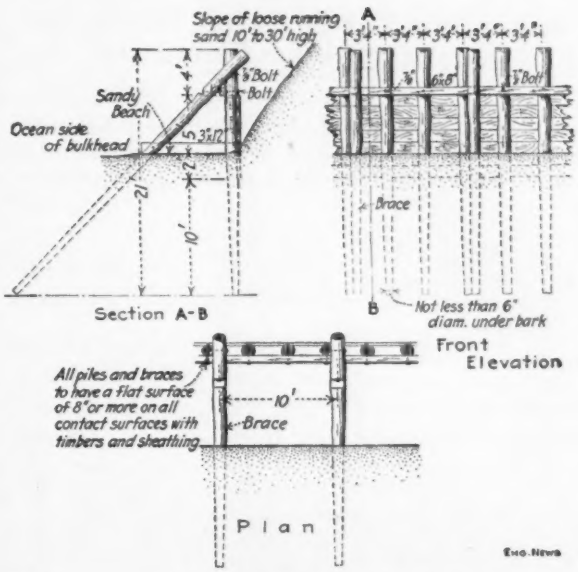


FIG. 2. CONSTRUCTION DETAILS OF THE 700-FT. TIMBER BULKHEAD

Groins 2, 3 and 4 (Fig. 1) will extend down the slope of the sand hill, follow an abrupt dip at the foot of the hill, and thence to a line about 6 ft. to seaward of mean low-water line. The outer ends of the groins will terminate on a 6-ft. apron—the only part of the work situated below low-water level. No. 1 will be of construction similar to the others, but will have no apron, as it terminates on a sand bar. The penetration of the piles in this groin will be but 8 ft.

The design of the 700-ft. timber bulkhead is shown in the sketch (Fig. 2). Piles not less than 6 in. in diameter at the point, with a penetration of 12 ft., will be spaced 3 ft. 4 in. on centers, in one row and will project 9 ft. above the beach on the ocean side. Every third pile is braced by a diagonal pile set at an angle of 45°, toward the sea, and bolted to the vertical pile. At the beach level a 3x12 is bolted with ⅞-in. bolts to both the vertical and the diagonal pile.

On the outside face of the vertical piles and touching the underside of the diagonal bracing, a 6x8-in. stringer is spiked. Horizontal planking of 3x12-in. pine will be spiked to the land side of each vertical pile, by means of two ½x½x10-in. galvanized boat spikes. Behind the bulkhead is a steep slope of loose-running sand from 10 to 30 ft. high.

*Our information on this subject was obtained through the courtesy of T. J. Rout, Inspector, Lighthouse Service, Department of Commerce and Labor, Philadelphia, Penn.

Cab Signals and Train-Stops Using Contact Rails have developed a new kind of danger which is similar to that experienced with strap rails in the early days of railways. The Great Western Ry., of England, has a cab signal system which indicates the position of the semaphore signals and which employs a contact rail 20 ft. long laid in the middle of the track. On March 7, one of these rails (near Reading) which had become loose or displaced was struck by the water scoop on the tender of a fast train. Being bent upward its end pierced the floor of the baggage car and then emerged through the roof, the bar being bent into the form of an S. It was so tightly wedged into the floor and roof that it could not be removed by the trainmen and the train resumed its journey, the lower end of the bar being so far above the track as not to be an element of further danger.

A Diagram for Solving McMath's Storm Sewer Formula

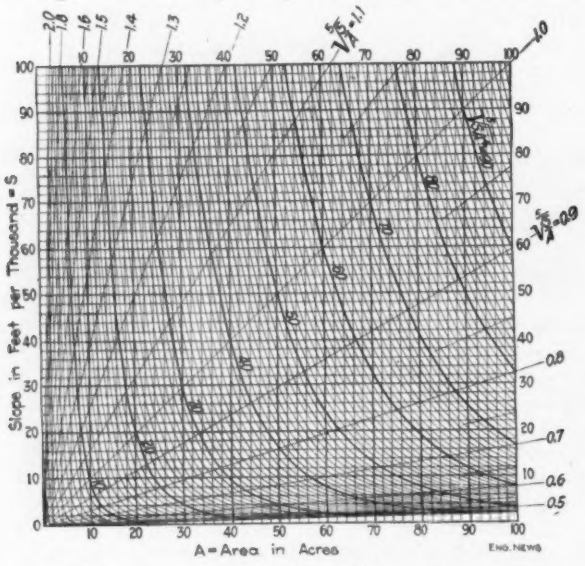
By R. W. Stewart*

In designing sewer systems for carrying storm water the engineer is often required to make extensive computations involving the use of McMath's well known formula,

$$Q = Cr\sqrt[5]{SA^4}$$

Since repeated solution of this formula without special facilities is rather tedious, various labor saving tables and diagrams have been used.

The writer submits herewith a diagram which is believed to be more ready and universal in its application than any heretofore published. For any values of S and A it gives the corresponding value of $\sqrt[5]{SA^4}$. This diagram has properties which make it easy to construct on any desired scale by the following procedure:



A Diagram for Solving McMath's Formula,

$$Q = Cr\sqrt[5]{SA^4}$$

First, plot the straight lines representing the values of $\sqrt[5]{\frac{S}{A}}$. To do this take even values of the expression $\sqrt[5]{\frac{S}{A}}$ and with even values of A compute the corresponding values of S. Since these lines are straight and pass through the origin a small number of points will suffice to plot them.

Second, for the values of $\sqrt[5]{\frac{S}{A}}$ represented by these radiating lines determine sets of values of $\sqrt[5]{SA^4}$ by multiplying $\sqrt[5]{\frac{S}{A}}$ by A. (In doing this it is most convenient to assume $\sqrt[5]{SA^4}$ at even values and with the even values of $\sqrt[5]{\frac{S}{A}}$ already plotted solve for A.) Plot the points thus obtained along the lines representing $\sqrt[5]{\frac{S}{A}}$, and, after a sufficient number of points have been determined, the curves connecting equal values of $\sqrt[5]{SA^4}$ may be drawn in.

The chart has the property that all intercepts between curves along any straight line passing through the origin are equal and this renders it easy to properly subdivide the lines.

In using the chart the decimal point in the areas may be shifted at will, provided it is correspondingly shifted in the slope and the value of $\sqrt[5]{SA^4}$, or, in other words, the value of $\sqrt[5]{SA^4}$ may be obtained for *any* acreage or *any* slope without going outside the limits of the chart as shown.

To computers familiar with the use of Sexton's Omnimeter (a circular cardboard slide rule) another point about the solution of McMath's formula may be of interest.

By transforming the formula as follows:

$$Q = Cr\sqrt[5]{SA^4} = CrA\sqrt[5]{\frac{S}{A}}$$

the value of $\sqrt[5]{\frac{S}{A}}$ may be determined at one setting of the instrument and the other factors then multiplied in to give the complete solution.

*Engineer of Bridge Department, Los Angeles, Calif.

A Small Suspension Bridge Wrecked by Unsuitable Cable Fastening at the Anchorage

The fall of a roadway suspension bridge, which was being erected over the Bued River in the Philippines, caused the death of 11 men of the erecting gang and the serious injury of ten others. While the accident occurred some time ago, the particulars have only recently become public in the official government report and its lessons as to care in the use of cable clamps are as important as if the disaster had taken place this week.

In the 1912 *Report of the Secretary of Commerce and Police,* the Director of the Bureau of Public Works, Warwick Greene, states:

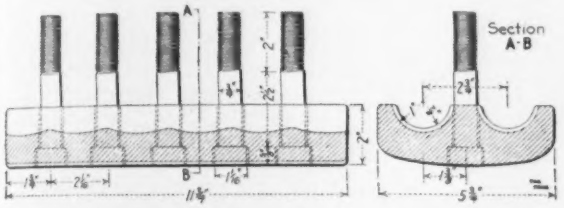
On Friday, May 31, 1912, a suspension bridge of 360-ft. span, which was under construction to replace the temporary structure spanning the cañon of the Bued River at kilometer 13.1, fell, and precipitated 21 workmen (15 Japanese and six Filipinos) onto the rocks of the gorge below. Eleven men were killed and the other ten more or less seriously injured. . . . Searching examinations have been made into the cause of this accident, which had not been satisfactorily determined at the close of the year. At the time it occurred two 2-in. seven-strand steel-wire cables with steel centers, on which the bridge was being suspended, were in place and the 21 men were engaged in laying the floor system. The cables had received about half of the total dead weight of the completed structure when one end of one of the cables slipped through the clamps holding it, throwing the entire weight of the structure on the remaining cable, which in turn slipped about 20 ft. on the opposite end of the bridge, where it was caught by its clamps and supported the wreckage of the structure. The floor stringers had not yet been nailed to the beams and together with the men working on them slid off into the river bed. The failure occurred suddenly, and without any warning whatever.

It is the opinion of the engineers, both in and out of the Bureau, who have carefully investigated the matter, that the cause of the accident can be attributed to the clamps used, which it is thought were unsuitable for the cable, due to no fault on the part of the Bureau of Public Works. No essential faults of erection were developed, but, as stated, the final determination of the question had not yet been reached at the end of the period covered by this report.

The bridge had two main cables, each made up of 7x19 wire, steel center, 2-in. outside diameter, galvanized, made and sold as "bridge cables." The end of the cable was passed around a loose sheave, carried forward parallel to the main cable, and clamped to it with five cast-iron cable clamps of the form sketched in Fig. 1. The two parts of the cable converging forward from the sheave were held together, back of the rear clamp, by a 1-in. U-bolt, to prevent injury at the entering side of the clamp.

It appears that the clamps were objected to at the start, because their internal diameter at the smallest point (top of corrugation) was 1¾ in., and much difficulty was experienced in making them fit on a 2-in. cable. The question was, in fact, referred to the manufacturers of the rope in the United States. They replied that the clamps were the proper ones for the size of rope furnished.

Two suspension bridges built prior to the Bued River bridge were erected without accident. One point of difference between them and the latter structure was that the earlier ones had the sheaves rigidly connected to the anchorage, while in the Bued River bridge the sheaves



One of the Cable Clamps Which Slipped and Wrecked a Suspension Bridge

were arranged so as to be free to turn. In the prior arrangement the difference in pull between the main cable and its return end produced a twisting effect on the anchorage connections, and the loose-sheave arrangement was intended to overcome this condition. In doing so, it increased the pull in the return ends of the cables, and thus subjected the cable clamps to heavier duty.

The ultimate strength of the 2-in. cable is given by the makers as about 160 tons. Tests made on the clamps after the accident showed that they slipped at loads ranging from 4500 lb. to 23,000 lb., depending on the degree to which the bolts were screwed up. The higher values were attained as the result of tightening the nuts during the test, i.e., after considerable load had been applied. If each of the five clamps took the maximum load of 23,000 lb. in its position on the cable, the fastening would be good for only 70% of the breaking load of the cable. The makers of the cable recommended using *four or five* of these clamps for a fastening similar to that used in the bridge; five were used in the bridge.

The total tension per cable in the finished bridge, under dead- and live-load, was computed to be about 90,000 lb. This would have loaded the clamps to 45,000 lb. (half the tension being taken off the rope by the clamps, and half going on in the main rope around the sheave), or each clamp would have had to carry 9000 lb.

At the time of the accident, the backstay tension in each cable was about 28,000 lb., or the load on the five clamps was 14,000 lb., which equals 2800 lb. per clamp. Under this load the clamps of one cable slipped.

The clamps depend for most of their holding power on having the corrugations pressed well into the rope. This condition does not appear to have been secured in the cable clamps of the wrecked bridge. After the accident, the remaining cable clamps were found to be not fully seated, in spite of the fact that the bolts had been screwed up so tight that an attempt to tighten one stripped the threads.

Tests of the Quality of Lubricating Oil After Long Use*

Tests of lubricating oil to determine whether it "wears out" or not in long-continued service, were recently made by Prof. R. C. Carpenter and Prof. W. M. Sawdon, at Cornell University, for the Richardson-Phenix Co. Samples were secured of filtered oil from the power plant of the Hotel McAlpin, New York City, where an installation of this company's central oiling and filtering system has been in service 1½ years.† For comparison, samples of fresh oil of the same quality and brand were secured.

A few of the comparative results of the study of physical properties are given below:

Color	New oil Medium red; translucent	Old oil Dark red; opaque
Flash point—open cup	410° F.	410° F.
Burning point—open cup	460° F.	440° F.
Specific gravity[1]	0.895	0.903
Relative viscosity[2]	70° F.—3.48	70° F.—4.66
	97° F.—2.14	103° F.—2.16
	130° F.—1.63	130° F.—1.62
	215° F.—1.22	218° F.—1.19

[1]Water = 1 at 60° F. [2]Water = 1 at 60° F., 27.9 sec. 100 cm., Olsen viscosimeter.

A series of tests were also made on a Thurston railroad-lubricant tester (hardened steel journal and bronze bearings of 20 sq.in.). The machine was run at constant speed of about 360 r.p.m. and bearing load applied in increments up to 75 lb. per sq.in. Oil was fed as nearly constantly as possible. Test at each load was continued until friction and temperature had become constant. The following figures have been taken from the data of these runs:

	Bearing pressure; lb. sq.in.	Duration test; min.	Temp. diff.; bearing and room	Minimum coefficient friction
New	75	120	46.3	0.01166
Old	75	150	46.0	0.01265
New	150	50	49.3	0.00666
Old	150	60	50.7	0.00717
New	225	60	58.0	0.00533
Old	225	60	57.2	0.00522
New	300	60	66.5	0.00458
Old	300	80	67.5	0.00458
New	375	50	70.5	0.00373
Old	375	50	59.7	0.00367

From the first table it is seen that the old oil had gained in specific gravity—as would be expected through loss of volatile constituents and the addition of small quantities of cylinder oil from piston rods and stuffing-boxes. The used oil showed a higher viscosity than the new, indicating that it gained in "body" with use.

The friction tests showed consistent results; the new oil had a slightly lower coefficient of friction on low-bearing pressures while the reverse is true for the higher pressures. The changes are so small, however, that the values are alike for all practical purposes.

*From information furnished by the Richardson-Phenix Co., of Milwaukee, Wis.

†Tests at the plant showed a circulation of 3600 gal. of oil per day or about 1800 bbl. per month. About 3 bbl. of fresh oil are added each month to make up for losses and withdrawals. Some 4 gal. of water per day are separated from the oil.

Storm Damage to a Natural-Gas Pipe Line in Southern California

The severe storms in southern California of late February interrupted the new natural-gas pipe line entering Los Angeles from the Midway field. On account of the severity of the storms, the effect on the countryside traversed was extreme in places and the number and extent of breaks to the pipe line were considerable. Yet in spite of this the repair was speedily completed and evidently at small expense, due largely to the character of the original design and construction.

This line is about 107 miles long from the intake station in Taft to the terminal house in West Glendale, just outside Los Angeles. These terminals are separated by the rugged Coast Range. The line leads from the oil field across a plain and rises to the mountains through Tejon Creek cañon. The mountains are crossed in the Santa Barbara National Forest, and the line descends toward Los Angeles through the drainage area of the Santa Clara River and its tributaries. The character of the country traversed is shown by the accompanying figures taken during the original construction of the line in 1912.

During this storm, there was almost no trouble evident in the mountains where any possible trouble would be expected, but the pipe line was put out of service below where probably no such trouble had been anticipated. Had storms of ordinary severity been encounterd, there would have been no serious damage on account of the methods taken to prevent interruption. The greatest damage to the line was done in the Tejon Cañon and this was the result of a complete change in topography of the district, which resulted from the storms in the previous January, and something which could not have been foreseen at the time the line was built.

Original Construction*—The pipe used weighed 31 lb. per lineal foot, being a lapwelded tube with plain ends, in lengths of from 11 to 40 ft., averaging 24 ft. The joints were made with a special coupling (Hammon type) to secure flexibility with tightness. This coupling consists of a steel sleeve approximately 8 in. long, being merely a piece of larger pipe with flared ends. The joint is made tight at each end of the sleeve by means of a rubber-ring gasket wedged in between the pipe and the sleeve by two steel ring clamps, of L-section, placed in either end of the joint sleeve and drawn up with crossbolts. These joints also take care of the expansion due to rises in temperature. For the first ten miles of line, the gaskets were of asbestos, since in that section there was expected to be a trace of gasoline vapor which is destructive to rubber. For the next 20 miles, the rubber gasket was protected by cotton wicking placed ahead of it before clamping up.

The pipe is buried in the ground with an average of about 2-ft. cover. Before being laid, the lengths were covered with a protective coating made from coal-tar base according to a formula developed by the designing engineers. For the first 30 miles of the line across the plain and in other level territory, ditching machines were used, but in the rough mountain sections, hand ditching was necessary. In some places it was necessary to cut through as much as 9 ft. in order to secure proper grade. Where the initial deflection of the couplers would have been more than 3½° (the maximum being 5°), tunneling was resorted to. In a very few instances where larger deflections were imperative, special couplers were employed. Wherever there were changes of direction, the pipe was anchored with concrete and wherever it was exposed it was tied to heavy concrete piers by means of 3x1-in. steel straps.

A suspension bridge was required over the San Fernando wash just south of the city of San Fernando. Near here, the Castaic and Santa Clara Rivers are crossed; these have, in summer, the appearance of dry washes, but during the winter storms carry large quantities of water heavily laden with bushes, trees and various débris. It was necessary, therefore, to put up a substantial structure; bents were made of jetted-in concrete piles spaced approximately 30 ft. apart with eye-beam tops to which the pipe couplings were fastened. The Castaic Creek trestle, shown in the accompanying figures, is 1208 ft. long, having 41 bents on 30-ft. centers. The Santa Clara trestle is 860 ft. long, having 27 bents. The San Francisquito Creek crossing was made by burying the line under the stream bed.

Storm Damage and Repair—It will be recalled that the heavy rainfall of the storm in question started in Los Angeles and immediate vicinity on Feb. 18. On the following night the storm extended to the north with a heavy rainfall in the headwaters of the Santa Clara River. On the third day there was practically a cloudburst throughout the Santa Barbara and San Gabriel national forests, the rainfall being reported at from 7 to 10 in. in various localities.

The damage to the Midway pipe line seemed to be confined to three general localities; (1) along the San Fernando road near the southern terminal; (2) in the Santa Clara district just north, and (3) in the Tejon cañon.

The San Fernandino road was itself badly scoured by the rainfall and the cover was taken from the pipe in several places. The Tejunga River cut a new course in this district, washing out the Southern Pacific R.R. track and flowing across the road. However, the damage here was speedily repaired. The pipe was merely pushed back to proper location and the gaskets tightened up. Rock and brush barriers were built in a few places where it was possible that future erosion might take place.

The San Francisquito River, at the pipe-line crossing, changed its channel and washed out two joints of pipe. The Santa Clara carried away two bents of trestle dropping three joints. Castaic Creek washed out three bents of trestle, but as they were not contiguous the pipe did not fall. In making the repair here, wood piles were driven (probably temporarily replacing the concrete) and new screw-joint pipe was laid in the bed of the San Francisquito.

In Liebre Gulch, the approach to the mountains from the southern end of the line, some 150 ft. of the line was

*The original line was built for the Midway Gas Co. by J. G. White Engineering Corporation, of New York City, W. E. Barrett being Chief Engineer of the project and H. M. Dougherty Construction Superintendent. The line was completed under this contract in ten months in spite of adverse conditions, and difficulty of holding men on the work during the hot months, and in the mountains and desert country. As an idea of this difficulty, it is interesting to note that the average pay-roll of approximately 680 men showed a total of over 11,000 names. Over a stretch of some 30 miles practically no water could be found and two springs had to be appropriated in the mountains with pipe lines to the work 12 and 9 miles long, respectively. In the northerly stretches the alkaline water encountered required the use of at least one lemon per man per day for the drinking supply.

VIEWS OF MIDWAY GAS PIPE LINE, CALIFORNIA, DURING CONSTRUCTION

(1) Curve around a Rocky Point in Tejon Cañon; (2) Entering Tejon Cañon; (3) Ditching in Liebre Gulch; (4) In Santa Barbara Mountains; (5) Steel and Reinforced-Concrete Trestle across the Bed of the Santa Clara River; (6) Castaic Creek Trestle; (7) A Mountain Creek Crossing; (8) Suspension-Bridge Crossing at San Fernando Wash.

washed out by change in the course of the creek. Here the pipe was merely replaced and loaded down with rock, although from the change in the creek it is probable that a relocation of the line one or two thousand feet further up on the hillside may be made some time.

The storm waters from Fraser Mountains, normally flowing into Lake Castac, in the previous January storms, broke through a divide here and flowed directly down Tejon Cañon to the north. While the storm raged to the south here, there was no rainfall—up to noon of Feb. 20. But then it started at 1 p.m. and reached a maximum at 4 p.m., with heavy wind. The total fall was some 10 in. The new wash of the Fraser flow into the Tejon Cañon, which was from 3 to 10 ft. deep and 20 to 40 ft. wide, was enlarged to 10 to 20 ft. deep and 100 to 200 ft. long for a mile and a half of length. In the lower reaches of the creek, where the elevation of the bed dropped from 3000 to 1500 ft. in five miles, the entire topography was changed, the bed being scoured down from 10 to 20 ft. and the course variously altered. The highway through the cañon was destroyed for a mile and the Midway line was washed out in various places. Another pipe line through here was uncovered and five electric transmission-line towers of the Southern California Edison Co. were upset. These towers had been in service ten years without interruption. The breaks on the Midway line were from 100 to 500 ft. long.

Where the Midway line was washed out at creek crossings in this cañon, it was replaced temporarily on rock piers and weighted down with piles of rock. Where the line paralleling the stream was washed out, a new ditch was dug back from the bank and the pipe relaid. In crossing the new channel through the divide the pipe was buried under the present bottom. It is only to be expected that, on account of the changes in the aspect of this cañon and in the light of this year's experience, it will be advisable to relocate the pipe line a few miles farther up the cañon side.

All the work noted was completed on Mar. 7, when the supply to Los Angeles was resumed.

Flashlight Railway Signals

The use of flashlights for railway signals, in order to make the signals more conspicuous and distinctive, is an old idea which is being revived in this country and in Europe. The purpose is twofold; first, to distinguish signals from other lights; and, second, to distinguish certain classes of signals from other signal lights. The Bezer signal which was tried experimentally in this country some years ago, had a semaphore arm revolving in front of the lamp and thus gave a flashing effect, but an objection to this was that the arm might stop in front of the lamp and so obscure it entirely. Flashlights have been applied extensively to gas buoys, and a flashlight tail lamp for trains was tried on the Grand Trunk Ry. about 1895.

Within the past three years a flashlight signal for railways has been introduced in Sweden, Russia, Denmark and the United States. The principal application is on the Swedish State Railways, where experiments were commenced in 1910. Six signals (home, distant and starting) at Liljeholm were equipped in this way, and the results were so satisfactory (even in heavy snowstorms) that in 1913 the system was applied to the 14 home and 22 distant signals between Stockholm and Saltskog. The home signals are of a three-arm three-lamp type, giving five indications, while [illegible] of the distant signals have two arms and lamps and give two indications. There are also nine distant signals at points where there is no junction, so that only two indications ("stop," "proceed") are required, and these have but one arm and lamp. The signal system was designed by E. G. Windahl, signal engineer of the railway. The night indications are as follows, the one-light distant signals showing only Nos. 6 and 7.

Home signal	Top lamp	Middle lamp	Bottom lamp
1. Stop	Red		
2. Main line route clear	Green		Green*
3. Main line clear, but stop at station	Green		Orange*
4. Branch line route clear	Green	Green	Green*
5. Branch line clear, but stop at station	Green	Green	Orange*
Distant signal (two lamps)			
6. Home indication: stop	Orange*	.....	.....
7. Home indication: main line clear (full speed)	Green*	.....	.....
8. Home indication: branch line clear (reduced speed)	Green*	.....	Green

* Flashlights.

The lamps are lighted by acetylene gas, and the flashing is effected by a valve in the lamp, operated by the pressure of gas in a diaphragm chamber of the valve. In the fixed lights, the gas is turned on only when the signal arm is in position corresponding to the lamp indication, being lighted by a pilot light. This is effected by a valve similar to that which gives the intermittent supply to the flashing lamp. For the home signal, there are 85 flashes per minute: 0.1 sec. light and 0.6 sec. dark. For the distant signal there are 60 flashes per minute: 0.1 sec. light and 0.9 sec. dark. The apparatus is on the "A. G. A." system, invented by Mr. Dalen, and was built by the Gas Accumulator Co., of Stockholm, Sweden.

The same flashlight signal system is being introduced in this country by the Commercial Acetylene Railway Light & Signal Co., of New York. The gas is stored in a cylindrical tank at the base of the post, one tank being sufficient for several months. Within the lamp is fitted the flashing valve, adjusted to give 60 flashes per minute, the duration of the flash being 0.1 sec. and the interval 0.9 sec. The signals are now in use experimentally on the Chicago Great Western R.R., the Boston & Maine R.R., and the Interborough Rapid Transit Co., New York.

On the Chicago Great Western Ry., the lamp is used on a single-arm three-position signal and shows a red, green or yellow light according to the position of the signal arm. The light flashes continuously for all indications (60 flashes per minute). We are informed that the lamp is supplied from a 12x44-in. cylinder containing about 225 available cu.ft. of gas, which is sufficient to supply the lamp for a period of about 281 days (24 hr. per day), continuous flashing. The light operates 60 flashes per minute, and the total gas consumption of both the pilot flame and head burner is equal to about 0.8 cu.ft. The light will flash 201,600 times on a consumption of one cubic foot through the head burner, at a cost of $15 per 1000 cu.ft. of gas. The total amount of gas consumed in 24 hr. costs 1.2c. So far as the intensity of the light is concerned, it is found to have about four times the efficiency of the oil lamps. On the Interborough Rapid Transit line (Manhattan Division), this signal was placed in service May 20, 1913; and the original charge of gas lasted till Aug. 21; the gas was renewed on that date and was still in service in January, 1914.

Some limited experiments with this system have been made in England (on the London & Southwestern Ry.), where the density of traffic is very much greater than on the Swedish railways. The conditions for applying special signals on English railways are exceptionally difficult owing to the great number of main tracks on busy main-line divisions, and to the frequent succession of main and minor branch-line junctions to be signaled. The possibilities of the application of flashlight signals under such conditions have been studied by J. F. Gairns, who reviewed his investigations in the "Bulletin of the International Railway Congress" (January, 1913).

The flashlight may be applied in three ways: (1) to all high-speed signals, both home and distant, as these need to be distinctive; (2) to all distant signals, to distinguish them from home signals; and (3) to the distant signals of high-speed lines only. Mr. Gairns considered the first plan open to the objection that two or more flashlights may be close together (which might be more confusing than two steady lights), while it gives no distinction between the home and distant signals. The second plan he considered to be so confusing as to be impracticable, especially in the signaling at complicated junctions, etc. The third plan, however, offers advantages in distinguishing the high-speed distant signals from all slow-speed signals and from the high-speed home signals.

Removable Winter Inclosure for Sprinkling Sewage Filters, Gloversville, N. Y.

By H. J. Hanmer*

Three acres of sprinkling filters, forming one of the units of the sewage-disposal plant, at Gloversville, N. Y., were placed in operation on Dec. 1, 1912. The design of the plant called for a portable covering and siding to be used during the cold winter months to protect the filters from damage that might result from the action of cold and snow, but due to the lateness of starting the operation of the filters and the scarcity of the necessary funds therefor, the lumber was not provided for inclosing the filters for the winter of 1912-1913.

One of the results of operating the filters in the open air are shown by the view, Fig. 1, which was taken on Feb. 10, 1913, when the snow and ice on the filters were the thickest. About the same time several measurements were taken of the open area on the filters, the average of which showed the area free from ice to be 30% of the total area of the stone in the filters. Due to the very mild winter, no damage was done to the filters, and it was possible to keep them in operation all winter.

In the fall of 1913, rough hemlock lumber was purchased and portable covering and siding were placed for the protection of the filters. In the original construction of the sprinkling filters, the regular 9x15½-in. reinforced-concrete beams were placed 12 ft. c. to c. and the 5x9½-in. stay beams were placed 24 ft. c. to c., at right angles to the regular beams. The regular beams were supported at the outside walls by 12x12-in. concrete columns which were grooved on two sides for receiving the board siding.

In placing the portable covering 2x6-in. hemlock timbers, 12 ft. long, were placed with one end supported by a stay beam and the other supported by a 2x4-in. piece resting on the filter stone. Inch boards were then spanned from one regular beam to the other, the centers of which were supported by the 2x6-in. plank lying on edge, thus making for the covering, supports 6 ft. apart. The inch lumber was purchased in 12-ft. lengths and 10 in. wide, the 2x6-in. in 12-ft. lengths and the 2x4-in. in 6½-ft. lengths. The total lumber required, amounting to 150,610 ft., was delivered at the site of the filters at a total cost of $4177. The cost of inclosing the filters by city labor was $205. The total cost of lumber and labor for covering three acres of sprinkling filters was therefore $4382.

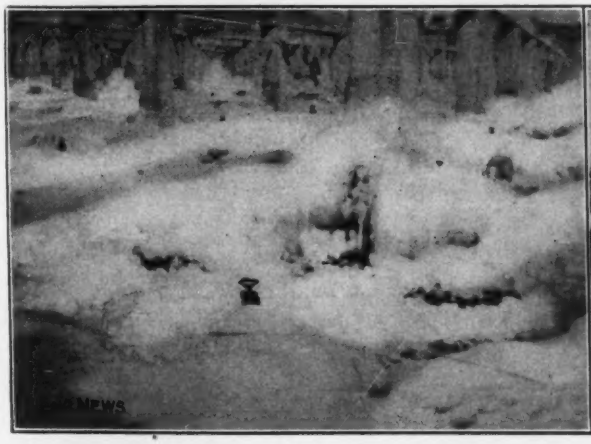


Fig. 1. Interior View Before Covering, Feb. 10, 1913. A sprinkler may be seen here and there in spots not covered with snow and ice.

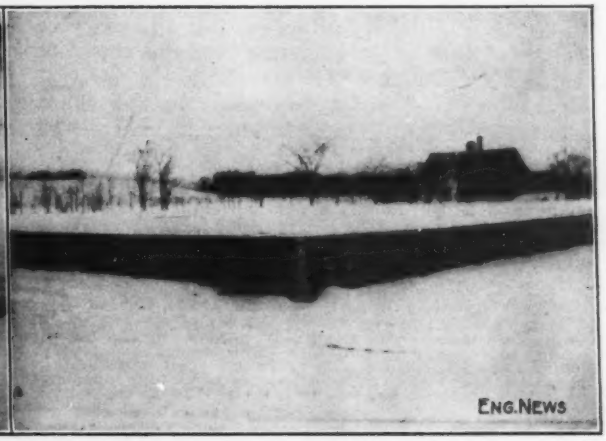


Fig. 2. Exterior View After Covering, Feb. 13, 1914. Flat wooden roof supported by concrete piers and beams shown in Fig. 1.

Winter Views of Sprinkling Sewage Filters at Gloversville, N. Y.

Three doors were placed on each side of the filters for entrance into the filters and also for ventilation.

The view shown as Fig. 2 was taken on Feb. 13, 1914, when the temperature was —6° F. At two or three different tims since Jan. 1, 1914, the temperature has been —30° F. for a number of days in succession.

*City Engineer, Gloversville, N. Y.

The Bactericidal, Deodorizing and Physiological Effects of Ozone

By F. V. Wooldridge, M. D.*

There has been much inquiry concerning the use of ozone both as a bactericide and as a means of promoting health. So much has been written for and against it that the writer has thought it might be interesting to record briefly some results of seven years' constant experience with ozone. The most of this experience has been in connection with the Pittsburgh Homeopathic Hospital, which has the largest plant of its kind in the world.†

As a result of this intimate contact and long experience, the writer disagrees with any universal condemnation of ozone on grounds yet announced, though he realizes that it may be used safely only where it has been carefully tested and above all that it is not the magic fluid which some rash promoters would have us believe.

As a physician, the writer is naturally interested in the use of ozone from the standpoint of therapeutics and sanitation. The following remarks will be confined to those phases of the subject.‡ It might be stated that the writer has made these studies of ozone without compensation and his work for the Pittsburgh Homeopathic Hospital was entirely gratuitous.

At what concentration does ozone have appreciable bactericidal effect in air? Strands of silk soaked in pure streptococcus culture were hung up in a large operating room (200 cu.m. space). About 2 cu.m. of air per minute having an ozone concentration of three were passed into the room. In 15 minutes the threads were taken down and similar infected threads used under a concentration of six. Next the air of the room moistened with steam until there was a decided deposit of water on the windows; then the experiment was repeated as before.

Results with the dry air showed that an ozone concentration of three had no appreciable effect on the bacteria, but a slight inhibition was noted at a concentration of six. With the air moist, there was a decided inhibitory effect at three and the bacteria were killed at six. There is, however, no small machine on the market that can produce a concentration of even one. It would be impossible for a person to stay more than a very few seconds in a room filled with ozone at a concentration of three or more.

At what concentration does ozone have an apparent deodorizing effect upon smells? It seems to depend on whether the smell is organic or inorganic. After bubbling ozonated air with a concentration of 2½ through a flask containing diluted typhoid patient feces for two seconds, no putrid odor was detected. In 15 minutes the solution was bleached and sterilized. The original solution was decidedly acid and the primary action of ozone seemed to be to neutralize these acids. Repeated trials with acid solutions have shown such neutralization before germicidal action begins.

In the children's ward of the Pittsburgh Homeopathic Hospital, when in the summer there are as many as 12 or 15 babies with bowel trouble, organic odors are never detected and yet no one complains of the odor of the ozone. Small amounts of high-concentration ozonated air are released to come up the elevator shaft and find their way about the place; neither ozone nor the usual hospital odors are noted.

Ozone has proved of great clinical assistance in treating offensive pus discharges. For instance, a patient was brought into the Second Ave. Emergency Hospital in Pittsburgh, with a perforating gun-shot wound of the abdomen. Though the patient was isolated in a private room hung with sheets saturated with antiseptics and deodorants, yet an offensive odor was so perceptible in the hallway that it was very distressing to other patients. This condition was eliminated by taking 12 thicknesses of surgical gauze about a foot square, saturating this pad with ozonated air and placing over the wound. Even in the room itself the odor was not really obnoxious.

In experimenting with putrid lard, the ozone seems to penetrate the solid cake about $\frac{1}{16}$ in., killing the smell until remelting was tried. By bubbling ozonated air through the melted grease all putrid odor was lost in a few minutes and the material was bleached.

Some recent experimenters have held that ozone only masks odors. It is the writer's experience that ozone actually destroys all of the organic odors and some of the inorganic. It seems to do this, as near as the writer's work shows, by combining with the sulphur and hydrogen in a molecule of putrid gas. Organic odors have a complex molecular formula and contain a large amount of sulphur for which ozone shows special affinity.

What are the physiological effects of ozone? A few years ago the writer spent eight months working constantly in the presence of this gas in amounts greater than necessary to destroy organic odor, and during that time he never enjoyed better health. It seems that if ozone is produced from cold, dry air, its effects are less irritating than from warm, moist air, probably due to the presence of nitrous acids and oxides in the latter case. Once the writer purposely spent two hours in a small room where fresh ozone at a concentration of two was being constantly blown in. There very quickly developed smarting of the eyes and mucous membrane of the nose with a constricted feeling in the larynx. At the end of an hour, a hard cough developed, and this persisted for four hours leaving the chest feeling raw. In a similar exposure of an hour, an asthmatic condition was induced in a subject and oxygen and aromatic spirits of ammonia had to be used in generous quantities for relief.

A human subject was placed for a week in an atmosphere with very small amounts of ozone. The gas was freshly and continuously introduced in minute quantities, about 1 cu.m. of ozonized air at a concentration of

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*Fifth Ave. and Beechwood Boulevard, Pittsburgh, Penn.

†Every room and every closet and cupboard in the building is piped so that by simply turning a valve one can get ozone at any place. The writer spent eight consecutive months, 12 hours a day, testing out this particular plant and along with it some of the smaller portable machines, making considerably over 5000 bacteriological tests alone.

‡Since there are very small ozone generators on the market, the makers of which claim great things for them, it seems necessary to note that the tests were made mostly with a five-unit (2-kw.) Girard apparatus, though smaller machines made by well known companies have been in constant use.

It should be noted that ozone is active in direct proportion to the voltage at which it is produced. A careful series of tests of the sterilization of given cultures shows that if 1 cu.m. of ozonized air of given concentration sterilizes in one minute with ozone-apparatus voltage of 10,000, when the potential is raised to 20,000 volts, for the same quanity and concentration of ozonized air, the culture is sterilized in half the time. It seems safe to assume, especially in view of other tests made in England recently, that where the electrical discharge is of very high voltage the resulting ozone will not have a formula simply of O_3, but O_4, O_5, or even O_{10}.

All tests mentioned involving the concentration of ozone (grams per cubic meter of air) were made using the iodide test. Further technic of the test is omitted, though it will be gladly furnished to any who desire it. Every test concerning germicidal action was made with a negative and positive control using B. coli, B. typhosis, B. streptococci, B. staphylococci, etc.

2½ c.m. coming into the room (150 cu.m. space) every three hours. In seven days and nights, the subject had lost 8 lb., but had a very vigorous appetite and said he had never felt better. He had done a greater amount of laboratory work than he did in either the preceding or the following seven days. No ill effects were noted whatsoever as regards blood pressure, blood or urine.

In a number of tests extending over a hundred separate hospital cases where the urine contained indoxyl (an unstable organic oil, possibly formed by putrefaction of albuminoids), in nearly every case the patient breathing ozone in such minute quantities that they were not conscious of it, showed the astonishing result of having this waste product entirely cleared up.

The writer has corroborated the published effects on small animals under high-concentration exposure. There has been decided congestion of mucus membrane in respiratory areas and, in addition, evidences of death from clonic spasm of involuntary lung muscle (alternate contraction and expansion).

So far as the treatment of disease goes, the writer has studied the use of ozone during the past eight years in cases of pneumonia, tuberculosis, whooping cough, syphilis, and auto-intoxication. In the treatment of lobar pneumonia, the writer prefers a portable ozone outfit to any other adjunct because he can keep the air of the room warm and at the same time free from certain organic wastes. In whooping cough, ozone seems at its best; the writer has yet to see a case where it did not increase the ability to accept nourishment, and diminish the paroxysms of coughing.

In tuberculosis, repeated tests show that ozone does not kill the germ at all, but does seem to oxidize bodily waste. Again and again, the writer has seen patients who were unable to accept the simplest food, enabled after exposure to minute quantities of ozone to partake more liberally of food, and better still, to seem to be able to utilize the food taken in. The ozone seems to stimulate the centers of nutrition. In all the cases whose history the writer has, without exception the number of germs in the sputum decreased; in a certain per cent. the bacillus disappeared and lung condition improved. However, it is useless to claim that ozone kills the germs directly—instead, it seems to raise the patients' resistance to a point where the leucocytes in the blood do this.

Ozone strong enough to kill bacteria ejected in the spray from the cough of a tubercular person would be very disagreeable and positively harmful. The sooner all get away from the idea that ozone helps the human organism by killing germs, the quicker will its true value be appreciated.

The Engineers' Responsibility for the Security of His Structures

The partial failures of three concrete bridges due to an unprecedented and extraordinary flood, on Sept. 3 and 4, 1913, in the Philippine Islands, inspired the following defense of the engineers in charge of the design and construction of these bridges by Clarence W. Hubbell, Chief Engineer of the Philippine Bureau of Public Works. This appears in an editorial in the January issue of the *Quarterly Bulletin* of the Bureau of Public Works; and because of the sound sense it contains the abstract given below is not only of interest but will prove a consolation to many a conscientious engineer whose work has failed from causes that could hardly have been foreseen.

It is obviously impossible to hold the individual engineer financially responsible for mistakes or failures. A single error of judgment on his part may cost more than his entire salary of a lifetime. Nor is it customary in any part of the civilized world to hold a professional man financially responsible. A captain loses his ship but he does not reimburse the owner for the loss, nor does he lose his standing as a captain unless investigation shows him to have been negligent in his duties. The average lawyer must of necessity lose at least 50% of his cases; but he does not reimburse his clients for their financial loss even though their cases may have been lost through his ignorance or incompetence. The doctor loses many cases; but he makes no financial reimbursement for his mistakes, though he may lose both prestige and practice if his mistakes are too frequent or too well known. Architects and engineers are required to design fireproof structures; but no one would think of holding them financially responsible for damages caused by fire.

There is a curious popular misconception that engineering is an exact science and therefore an engineer should make no mistake. Nothing could be further from the truth. As well say that because the rules for computing interest are exact the business man should make no mistakes or failures. In fact, the very engineering formulas used for computing the size of a beam, the flow of a river, or the bearing value of a pile are based on assumptions that are only approximately true and in some cases may be as much at 50% in error. The results obtained by their use depend entirely on the skill, experience, and judgment of the engineer who applies them. He must select the constants to be used just as a business man must from his general knowledge decide whether a certain enterprise will pay 2 or 20% on the investment.

An engineer pits his training, experience, and skill against the unknown in nature. His structures must stand against flood, typhoon, earthquake, fire, and decay. In addition to these unknown quantities he must also provide against the uncertainties of imperfect workmanship, variable character of materials used, and the vagaries of foundations, as well as the use and abuse to which his structures may be subjected during their life.

In the beginning, engineers untaught by experience and unskilled in technical knowledge provided against all unknown factors by building structures five, ten, twenty, or even a hundred times as strong as they really needed to be. In those days expense was a secondary matter. In the present day, from a business point of view, the best engineer is the one who can secure the largest useful return per dollar invested.

The general public should understand that it requires no engineering skill to build structures of such enormous proportions that there is no possibility of failure. It does require engineering skill, however, to so design and plan structures as to get reasonably safe and satisfactory results with the least amount of expenditure.

It takes no small degree of courage for an engineer to assume the risks necessary for true economical design and construction, knowing as he knows that the probable failures incident to such a policy are likely to bring upon him an unintelligent and unjust criticism, which in the case of a young engineer may even ruin his reputation. It is the province and policy of the Bureau of Public Works as an organization to protect its engineers from such unjust criticisms. This does not mean that incompetency, gross errors, or ignorance of correct principles will be condoned. It does mean that legitimate business risks intelligently assumed will not be held against any engineer in the service.

Investigations of Industrial or Trade Waste Disposal are to be made by the United States Public Health Service. It is expected that first of all an experimental plant for the study of the economical disposal of tannery wastes will be built and operated. It is also hoped that some of the work will be done on strawboard wastes and perhaps on one or two other classes of waste of such general occurrence as to make the problem of their disposal of considerable importance. These studies will be in the direct charge of Harry B. Hommon, recently appointed as Sanitary Chemist, United States Public Health Service. They will be conducted under the supervision of Prof. Earle B. Phelps, chief of the Division of Chemistry, under the direction of Dr. John F. Anderson, Director of the Hygienic Laboratory, United States Public Health Service, Washington, D. C.

East Side Tunnel of the Rhode Island Co., Providence

By Heaton R. Robertson*

SYNOPSIS—The engineer in charge of design and construction here gives an interesting report on construction of a tunnel which will improve the transportation facilities in Providence. Some difficult work is described in working under a large brick structure and in soft ground under heavy residences. The methods of timbering, concreting and bench excavation as carried on in the long rock section, make a notable addition to American practice.

Various schemes have been proposed to improve the transportation facilities in Providence, where troubles arise from having the chief residential section on a hill about 125 ft. in elevation above narrow and congested business streets. The two most popular schemes have been a graded highway on a viaduct and a tunnel for street cars only. Finally, in 1912, the General Assembly in a franchise, empowered the Rhode Island Co., which operates the street-railway system, to build the tunnel in the location shown by the accompanying plan. The city secured the right to purchase the tunnel at cost on completion. In June, 1912, the writer was placed in charge and preliminary work was begun.

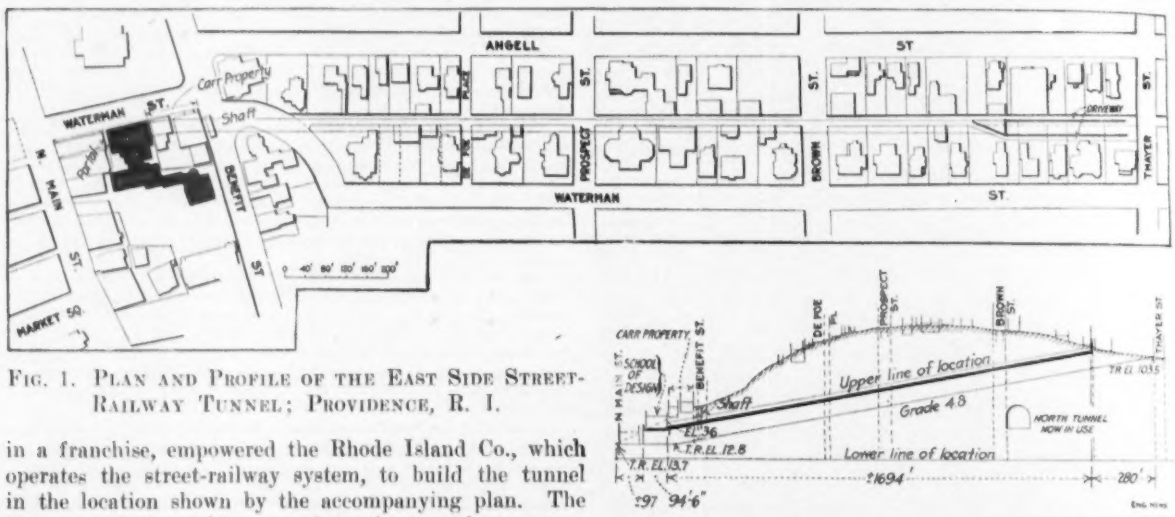


FIG. 1. PLAN AND PROFILE OF THE EAST SIDE STREET-RAILWAY TUNNEL; PROVIDENCE, R. I.

As there are now at least 4000 railway tunnels, built in many countries and under widely varying conditions, many different methods of tunnel construction have been used. Each given problem of design and construction is dependent on surrounding conditions, and given these as a basis the solution logically develops. The construction methods employed in this case proved similar to those most commonly employed in Europe but comparatively little followed in this country.

Three main feaures of the undertaking presented themselves at first—the condemnation of property, the plans and specifications for awarding of contract, and the methods of construction. All were closely related.

CONDEMNATION—The first step was a determination of tunnel size and approximate alignment referred to city street lines. The width of the tunnel was made 25 ft., which with tracks on 11-ft. centers gave a clearance of 2 ft. between the outside of a 10-ft. car and the sidewall. This is sufficient for any future needs, as larger cars with a wide spacing of tracks cannot be used on account of the narrow streets of Providence. The height of the tunnel was made 17½ ft. above top of rail at the center with a view to giving about 16 ft. 5 in. over the center of each track as determined by a preliminary sketch. This gives a clearance of at least 3 ft. 6 in. over the largest street car now operated in either Rhode Island or Connecticut. More clearance is required by cars with a trolley pole than by those operated from third rail, for in the latter case a total height of only 14 ft. 9 in. over track centers has given satisfactory results.

For condemnation purposes, 7½ ft. was allowed on each side for the walls, overbreak, or possible change of alignment, thus making the entire width to be taken 40 ft. Inasmuch as no appreciable change of alignment was made, an allowance of 5 ft. on each side would have sufficed. An allowance of about 5 ft. in addition to the extreme height above top of rail was made for crown bars and lagging overhead. The lower limit of easement was taken at sea level, it being expected that damage claims would be based upon the distance of the upper line of easement from the surface of the ground.

The northerly line of condemnation followed the northerly line of Fones Alley and the southerly line was taken 20 ft. southerly of the proposed center line of tunnel, and so described. Had this southerly line of location been described as passing from point to point on each cross street it would have been easy to determine the points where it crossed each property without running out the whole line. No difficulty arose in this connection but had the location of the line been questioned, such a scheme would have prevented much trouble.

As soon as the papers and plans were filed and a bond furnished, the company had the right to enter the ground in order to begin construction.

PLANS AND SPECIFICATIONS—An accurate closed sur-

*Division Engineer, The Rhode Island Co., Providence, R. I.

vey was run from a point on the line of Waterman St. (which is parallel with the west approach) over the surface of the tunnel to a point in the line of the proposed east portal, thence around the block and back on another street to the point of beginning. The accurate distance

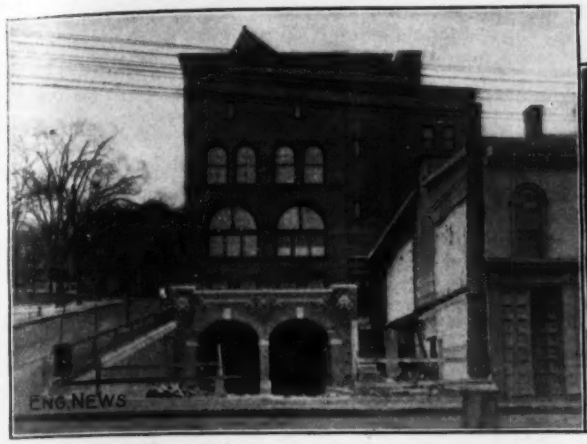


FIG. 2. WEST PORTAL AND RHODE ISLAND SCHOOL OF DESIGN

FIG. 3. EAST PORTAL AND APPROACH

and direction of the center of the east portal from the west approach could thus be located by the method of latitudes and departures. The long tangent of the tunnel was then run over the hill on a 7-ft. offset in Fones Alley and marked permanently by copper nails in three 12x12-in. blocks, 3 ft. long, set in concrete.

The arched section of the tunnel was studied with care, and a standard section (Fig. 4) determined which it was thought would contain a minimum thickness of arch and walls in the ground that it was expected to encounter. This proposed standard section was intended to be a basis for bids but was subject to change at any time upon payment of unit prices for extra concrete or extra excavation involved. The shape of the intrados as already outlined was dependent chiefly upon the clearance re-

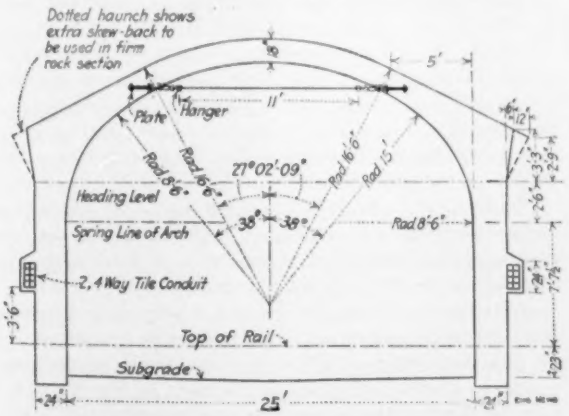


FIG. 4. TYPICAL SECTION OF MAIN TUNNEL

quired; however, a flatter arch might be used to advantage in a very deep tunnel, where pressures might come more from the sides than would be probable in a tunnel near the surface. The extrados was designed with a view to giving the arch a uniform strength according to the elastic theory when the loads were assumed to be vertical. The skewback was for the purpose of giving support to the arch until the sidewalls were in place, as by the adopted method of construction the arch was to be built first.

Two lines of four-way conduit were placed behind each sidewall, waterproofed, and covered with concrete. Conduits are often placed in the bottom of a tunnel near the walls and thus form a convenient walk, but probably cost more, as when they are placed behind the walls less extra concrete is required, and the overbreak will take care of most of the excavation. The possible rental value of such conduit in a large city is obvious. Splicing chambers were designed 6 ft. high and 4 ft. wide to be placed alternately and 160 ft. apart in each wall.

Eye-bolts (¾-in.) were placed on each side of the arch for the support of cross spans to carry the trolley wires and were set back beyond neat lines in order to give a longer span at the proper elevation. There are several methods of supporting trolley wires in a tunnel and the question was given careful consideration. The less clearance required for supports the less is the height of the tunnel, with a presumable decrease in cost. Some of the methods requiring least clearance, however, are open to certain objections. The more expensive trolley rod, rigidly fastened to the roof of the tunnel, is apt to be noisy and to cause annoyance to residents overhead, while the ordinary trolley wire attached to fixed hangers over the tracks will wear unduly at the points of suspension. By sinking the eye-bolts into the concrete a satisfactory cross-span can be used with but little loss in clearance. The trolley wire could be offset from the track toward the center of tunnel if necessary.

The plans of construction under the School of Design were worked out in detail before bids were asked, as it was then thought the work would be begun at this point. The front wall of the building (Fig. 6) and a parallel brick partition wall to the south could rest upon the tunnel sidewalls, and the cross walls and partitions of the building be carried on girders. In order to reduce the depth of these girders and to give more clearance underneath, they were designed to rest upon center columns. In order to avoid settlement, the tunnel walls for the support of the school were designed heavier than would have been the case had they been intended for the original foundation of the building. The use of the center columns necessitated a wider tunnel at this point, and as the tun-

nel curved toward the east it gradually narrowed to the standard section, which gave each arch ring for the next 112 ft. different span and radii. Heavier side walls were required as shown in Fig. 6. This curved and narrowing section was to be another special piece of work on account of its position in soft ground only 6 to 8 ft. under the two heavy residences of the Carr property (Fig. 1).

Retaining-walls for the east and west approaches were designed approximately, for the purpose of estimating unit bids.

It is often a considerable problem to find the best means for the economical disposal of a large quantity of material to be taken from the center of a large city. Perhaps the cheapest plan considered would have been to load into trolley cars at the west approach or in the tunnel and haul through the city streets to a dumping ground three miles distant. It happened, however, that the material could be used to advantage in filling a trestle of the New York, New Haven & Hartford R.R. over the Seekonk River; and although a shaft and temporary trolley line in Benefit St. was required to load the standard-gage cars for the purpose, this was offset by other considerations and became the adopted method. By means of the shaft the longer portion of the tunnel to the east could be begun at once, without waiting to finish the shorter but slow and more difficult portion under the School of Design and the Carr property. With the installation of the line along Benefit St., a vacant lot, at the point where the steam cars beneath were loaded, could be utilized for mixing concrete and storing materials. In this way, while the disposal itself, measured in terms of actual hauling and dumping, was not cheap, the whole system became economical and efficient.

In preliminary work of this kind it should be borne in mind that general plans may be considerably altered in detail as construction progresses. But the experience here shows that this should occasion no difficulty where unit prices are bid. Great care was given to the specifications, however. It was essential that they should be an accurate and final explanation of the intentions of the company in regard to the work of construction. No amount of thought in such cases is wasted in making specifications detailed and comprehensive. For instance, they should describe the work in general and explain fully what is required for the payment of each unit price; to avoid frequent causes of misunderstanding, the definition of rock excavation should be precise, and it is well to define common excavation as excavation of all other material; there should be a description of the quality of concrete required, and a synopsis of material to be furnished by the contractor and by the company; provision should also be made for extra work, or work done at the request of the Engineer which cannot be included in the bids.

Preliminary Work—When the contract was awarded, the plan of construction was resolved into several parts: The 95 ft. of special construction under the Rhode Island School of Design; the 112 ft. of soft ground tunnel under the two heavy residences of the Carr property adjoining; the 1585 ft. of long tunnel tangent; and the grading and concrete at the approaches. The easterly 75 ft. of the long tangent was to be excavated by the cut-and-cover method.

Preliminary work consisted in sinking the shaft in Benefit St. at a point which divided the long straight portion of the tunnel from the short sections of special work to the west. An extra siding was installed near the portal of the steam-road tunnel which passes under Benefit St. two blocks to the north, and above this siding the contractor built a timber trestle to support storage bins beneath a narrow-gage track which runs thereon along Benefit St. to the shaft. By means of this track, excavated material which is hoisted from the shaft is hauled by a trolley locomotive to the bins where it is dumped into standard-gage cars beneath, these being hauled at night to the Seekonk River and dumped. The greater part of the material from that portion of the tunnel below Benefit St. to the west was hauled up the hill by team and then to the bins.

The shaft was commenced Nov. 12, 1912, and was sunk a short distance below tunnel subgrade, a slab of concrete

Fig. 5. Benefit St. Shaft and Part of Carr Property

12 in. thick being placed in the bottom. The entire shaft was in soft ground and the depth from the street to the top of the tunnel about 15 ft. Spoil was lifted by a 75-hp. electric hoist installed in the street. When the upper portion of the tunnel was being excavated, the 3-yd. narrow-gage cars which operated in Benefit St. were lowered below heading level to receive the material from the small steel cars used in the tunnel. When the lower portion of the tunnel was being excavated, 3- and 4-yd. cars were lowered to the bottom of the shaft and hauled by a locomotive to the shovel used.

The concrete mixer, the cement shed, and the various concrete materials were located in the vacant lot near the bins, and concrete from the mixer was hauled through Benefit St. by the electric locomotive (Fig. 5) to the shaft. The compressor plant and blacksmith shop were installed in the basement of a building purchased in connection with the acquisition of property for the west approach of the tunnel (seen at the right in Fig. 2). One-half of the building originally stood on the ground required for the west approach and the remaining half, besides affording space for compressor and blacksmith shop, gives room above for construction offices of the company and the contractor. A vacant lot near the east portal served as space for the concrete plant and storage of material to be used in the construction of the east approach and the cut-and-cover portion of the tunnel.

As soon as the shaft was finished, the top heading of

the long tangent of the tunnel was begun. When this work had progressed some distance, a drift was run from the shaft westerly to the location of the west portal and a pipe from the end of this drift connected with the city sewer in North Main St., to provide drainage and guard against the danger of filling the shaft and workings with water in case any considerable amount of ground or spring water was encountered. Water in abundance, by filling the workings, would have washed the earth from behind the timbers and thereby endangered the work. This drift was in firm glacial till for the entire distance and no rock was located under the Carr property or the School of Design. The portion of the tunnel to the east was in this same material for about 200 ft. before rock of any stability was found. The greater part of the tunnel was in graphitic carboniferous schists considerably fractured by compression. In driving the drainage drift a location was chosen along the southerly tunnel wall as far as the face of the School of Design and thence to the portal under the portion of that building carrying the least load. One tunnel sidewall from subgrade to spring line was then concreted in the drift under the Carr property.

SUPPORTS FOR THE SCHOOL OF DESIGN—After the construction of the main tunnel was well under way, in the beginning of February, 1913, the underpinning of the school was begun. This building is a three-story brick structure (Fig. 2), the foundation walls of which support a load of about 16,000 lb. per running foot. The north and west walls are pierced by large arched windows which concentrate the building loads on six piers along Waterman St. and three piers across the entrance of the tunnel. Two lines of iron building columns and two brick partition walls cross the tunnel opening. A longitudinal partition wall runs two-thirds the distance through the building directly over the south wall of the tunnel. The easterly outer cross-wall has no openings. The building rests on a sidehill, and a 10-ft. drive west of the building was supported by a masonry wall which has now been replaced by a reinforced arch and parapet composing the portal of the tunnel. It was found when driving the drainage drift that the west wall of the building extended to within a few feet of the level of the west approach below, and was doubtless so constructed to prevent sliding of the structure.

The general plan of procedure was to underpin the front wall of the building with the north wall of the tunnel and the longitudinal partition wall 29 ft. distant with the south wall of the tunnel and to connect this south wall with the wall already placed in the drainage drift under the Carr property. It was proposed, as soon as sufficient portions of the tunnel walls were completed, to excavate shafts in which to place the steel-center supporting columns; then to set in place one at a time the steel girders which were to carry the transverse lines of cast-iron columns, brick partitions and outer walls. The work was accomplished as follows:

Needle beams spanning the location of the north tunnel sidewall and resting on blocking were placed to carry the first two piers of the front building wall. A trench about 15 ft. in length under the corner of the building was then excavated and braced with 3-in. sheathing, after which the concrete wall was brought up by degrees and the crossbraces removed as concrete was placed. This wall was brought to within 6 to 12 in. of the bottom of the building wall and when the concrete had set, brick piers were built to within one course of the foundation. The next day the final course was put in and pinned with iron wedges driven into the mortar. Plates with parallel wedges are sometimes used for underpinning but the method employed was satisfactory and no settlement was recorded in connection with it. Each 15-ft. section of wall was underpinned before the adjoining section was excavated and, by working on alternate sides, the length of building wall needled at one time was minimized. As soon as the two piers on opposite sides of the tunnel at the west wall of the building were underpinned the needle beams were removed and used to support the central building pier. A pit was then excavated to a depth of 22 ft. and concrete for a center column base placed. After

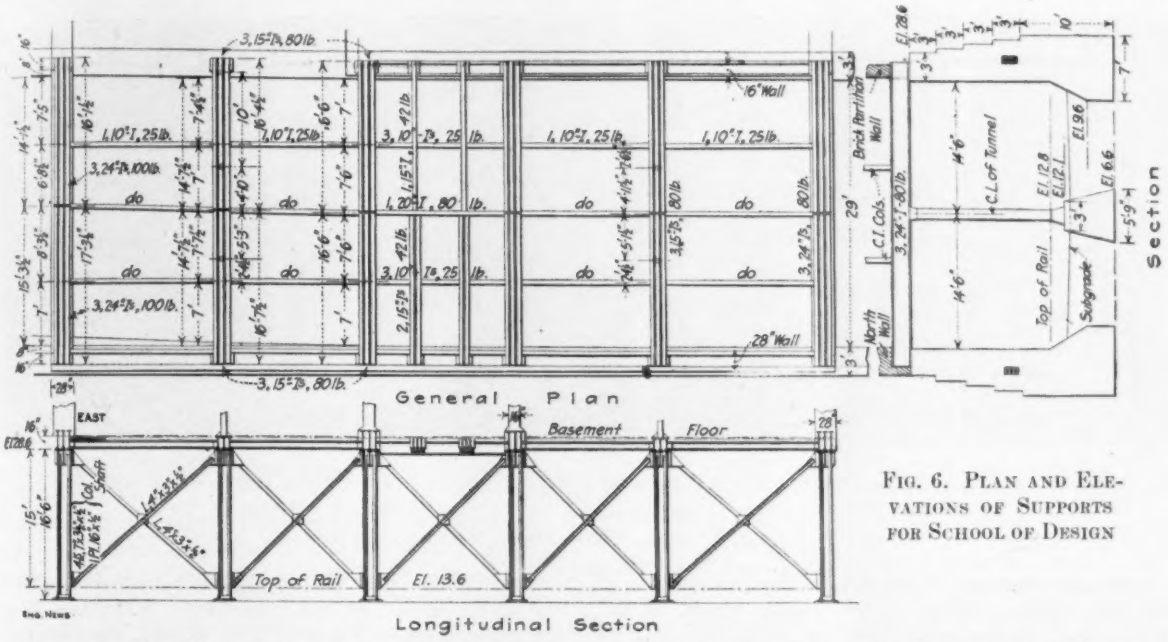


FIG. 6. PLAN AND ELEVATIONS OF SUPPORTS FOR SCHOOL OF DESIGN

a set of about six days, the steel column was erected. Up to this point the portions of this west wall between the needle beams at the center and the ends supported by the tunnel walls, rested on their original foundations. The whole north half was then needled, from column to tunnel wall, with small beams and the original foundations were cut away to allow placing the triple girder (Fig. 6). This girder and all the similar ones shown consisted of three 24-in. I-beams bolted together and riveted to a common plate at the wall end. The north half of the wall length was then pinned off by bricking up on top of this girder. The south half was needled and a girder put in similarly; then the heavy needles were removed from the central pier. The brick partition walls, the lines of cast-iron columns, and the easterly outer wall of the building crossing the tunnel were supported in a similar manner. The basement floor was replaced by a reinforced-concrete slab.

half of Fig. 9, the width along the tunnel being about 6 ft. In connection with this work, Drift 4 was driven a distance of 8 ft. or 2 ft. beyond the enlargement to enable continuation after the concrete arch was in place. Drift 4 was not a drift in the ordinary sense as it was only for setting up the segment posts and facilitating enlargement.

The enlargement was carried from the center toward the haunches by laying steel lagging piece by piece, supporting these at one end by the segment in place and at the other end by temporary 3-in. planks. The center of each piece of lagging was also supported by 3-in. planks where the ground appeared heavy. The steel lagging was $\frac{3}{8}$x6 in.x6 ft., weighing about 600 lb. per ft. of tunnel length.

As soon as the enlargement was completed, 8x12-in. segmental timbers were put in 3 ft. apart and the ground excavated to within a couple feet of the spring line; then

FIG. 7. BEGINNING NEW FOUNDATIONS, DRAINAGE DRIFT AT THE RIGHT

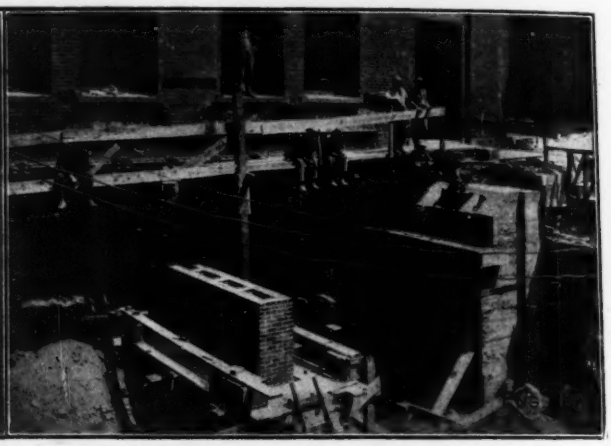


FIG. 8. STEELWORK UNDER WEST WALL AND FOUNDATIONS OF DRIVEWAY ARCH

FIGS. 7 AND 8. TUNNEL WORK UNDER SCHOOL OF DESIGN

After the foundations and steelwork under the school were completed, a double reinforced arch, carried on the two sidewalls, and a central pier of brick was built to carry the 10-ft. driveway of the school; a brick parapet wall, built at the edge of the driveway, served as a railing to the drive as well as for the architectural features of the portal.

WORK UNDER THE CARR PROPERTY—As soon as that portion of the north wall of the tunnel which supports the School of Design was in place, a drift (No. 2, Fig. 9) was run westerly from the shaft along the location of the north tunnel side wall to connect therewith. The side wall was concreted in this drift from subgrade to spring line similarly to that previously placed in the drainage drift on the opposite side of the tunnel. The space behind these walls was filled with boulder concrete.

The remaining core under the greater portion of the School of Design being removed by teams, a top center heading drift (No. 3, Fig. 9) was excavated from the School under the residences of the Carr property to the shaft. Steel lagging was used in the roof of this drift and was set at the grade of the proposed extrados of the arch. Wood lagging was used at the sides where necessary. When the center drift had progressed sufficiently, enlargement was begun, as shown in the right the steel centers were set up, covered with beveled strips and a 5-ft. section of arch concreted. When this ring had set sufficiently the next 6-ft. section was enlarged and the arch ring placed similarly. This method of operation was carried on simultaneously from each end of the portion of the tunnel under the residences in question, and by having open only a small amount of ground at one time the dangers from settlement were reduced to a minimum. As soon as the arch was completed the rest of the core was removed between the west portal and the shaft and the excavation carried to subgrade. Only a few segmental timbers were removed. No difficulty was experienced in packing concrete around the segments. There was some settlement of the residences overhead as for a part of the distance nothing but sand was encountered overhead.

The lowest point in the tunnel is under these buildings, about 120 ft. from the west portal, where a brick catch basin 4½ ft. in diameter and 7 ft. deep was constructed and connected by an 8-in. pipe to the North Main St. sewer. Small pipes running to this basin drain the ground under the School while a 6-in. pipe brings the drainage from the main tunnel.

MAIN TUNNEL—The method of driving the long tangent of the tunnel was somewhat unusual in certain fea-

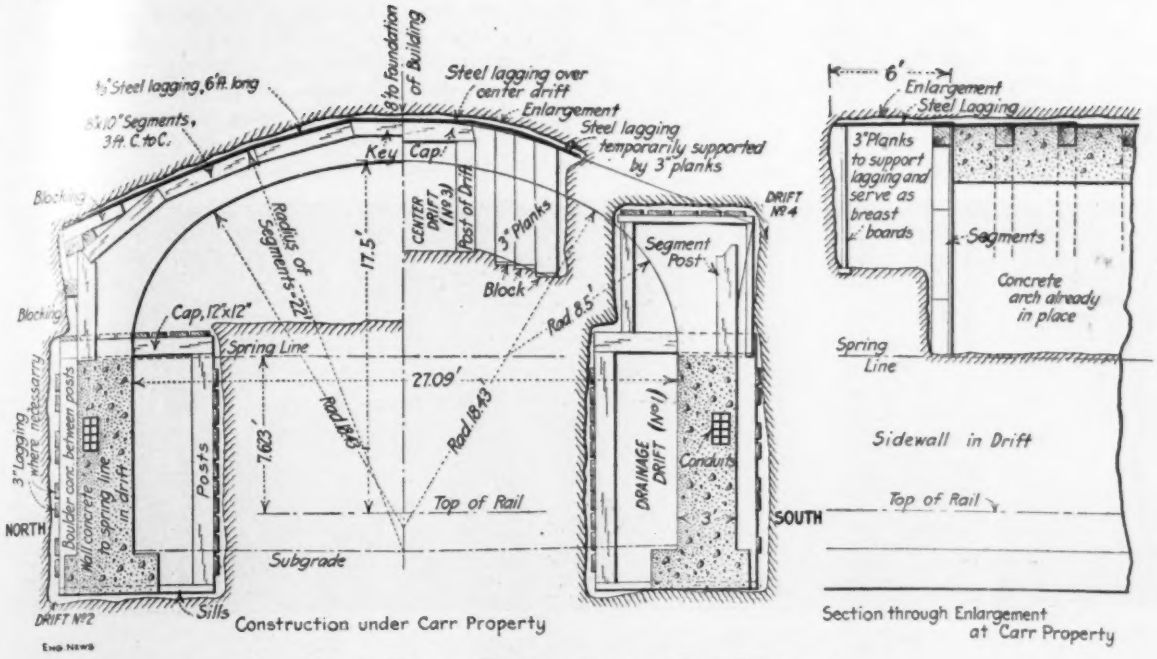


FIG. 9. TUNNEL TIMBERING UNDER CARR PROPERTY

tures. First, a center drift was driven below the crown, as shown in Fig. 10; this was next enlarged to the full width of the tunnel, the ground overhead being supported by lagging, crown bars and posts. Next, centers were set up and the arch rings concreted, the haunches resting upon the ground. After this portion of the tunnel above heading level was concreted its entire length, the lower part, or bench, was excavated to subgrade between the neat lines by steamshovel, and as this work progressed it was followed by excavation and concreting of sidewalls.

This method has proved successful in a number of instances. In soft ground, however, it is not suitable as settlement of the arch would undoubtedly occur between the time of excavating the bench and placing of sidewalls. In this case, for the short distance east of the shaft in which soft ground was encountered, the sidewalls were put in trenches excavated in short sections before the core was removed. In the hardest kind of rock, blasting of the bench is likely to crack and disfigure the arch, the method being most advantageous in ground which, like the case in hand, consists of a rock soft enough to be easily broken and at the same time of sufficient strength and firmness to stand without danger on the vertical plane of the neat lines. The purpose of the skewback is for support of the arch while the bench and sidewalls are being removed and the wall concrete placed.

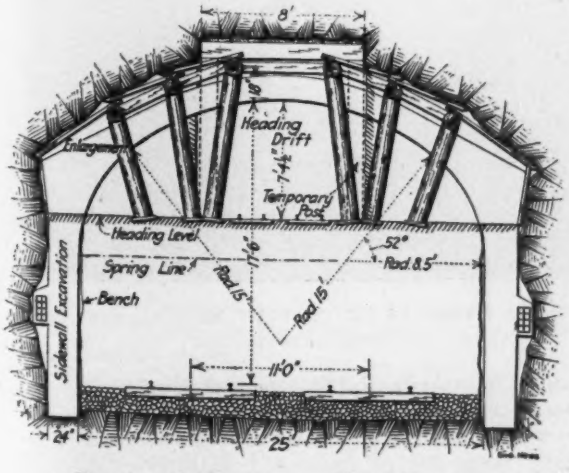


FIG. 10. TIMBERING IN MAIN TUNNEL

HEADING AND ENLARGEMENT—The upper drift was started Nov. 26, 1912, work being pushed day and night. It was 10 to 11 ft. high and of a width requiring 8- to 10-ft. caps. With the exception of 75 ft. it was driven from one end only and was holed July 16, 1913; the length being 1495 ft., an average rate of progress of 6½ ft. per day was made. This figure is not a fair idea of progress, however, as work on the heading was stopped while the drainage drift was being driven, and, moreover, as it was a short tunnel, the usual delays in the first few weeks count heavily against the average. During the last four months an average progress of 235 ft. per month was made.

The method of timbering the heading drift (Fig. 10) consisted in placing sets of caps and posts about 5 ft. apart, the ground being supported overhead with 2-in. lagging. As soon as sufficient space was made the caps were supported by oak crown bars 20 to 25 ft. long, resting on batter posts 5 or 6 ft. apart; the original temporary posts being removed and used again for posting caps. The crown bars were kept in position by stretchers. In ground where 20 ft. could be tunneled without timbering, the crown bars were put in directly.

Excavated material was trammed to the shaft in one-ton steel cars which ran down the 4.8% grade on a narrow-gage track, the empty cars being pulled back to the heading by mules. Stalls for the latter were erected under the portion of the arch already concreted.

The alignment of the first 300 ft. of heading was

found by dropping two plumb bobs down the shaft on the center line. When the heading had progressed 300 ft., a 6-in. well hole was sunk from the surface on the 7-ft. offset line established over the hill and the line of the rest of the tunnel was found by plumbing down this hole and down the shaft. The final error at the other end was negligible.

vated per day. Although a low-grade explosive will usually break soft or fractured rock to better advantage, 60% dynamite was used here in order to reduce the volume of smoke. No means of ventilation was employed other than that afforded by the use of compressed air, and the atmosphere became decidedly close during the last month before the heading was holed.

FIG. 11. UPPER HEADING AND ENLARGEMENT; MAIN TUNNEL

As soon as the heading had been driven about 150 ft., the enlargement was started and an effort made to keep it a uniform distance from the heading. Taking a section equal in length to the crown bars, the ground was excavated toward each haunch from the center drift, lagging being driven over the bars and pointing across the tunnel. As soon as sufficient space was made the No. 2 bars were placed and posted, the process being continued until the enlargement of the entire section was complete. The skewback was often not cut, however, until just before the forms were set up. The operation was essentially the same as though a drift 20 or 25 ft. wide was being driven across the tunnel to each side from the center.

As the bars were set above the required extrados, a space was left under the lagging between them which had to be filled either with concrete or dry packing; this space also represents overbreak. Yet if the bars were set lower it would be necessary to chop them out in short lengths as each ring was being concreted, a process which seriously interferes with the operations of the concrete crew. In any case it would be advisable to make an allowance to provide for bars not placed at precisely the correct elevation and to allow for possible settlement. To insure an adequate height of lagging at all times this allowance should be equal to at least one-half the diameter of the bars. It was thought best, therefore, to set them clear of the required extrados in the first place in order to diminish the amount of necessary cutting and to facilitate the concrete work.

The drilling of the heading was done by an average crew of one foreman, four drill runners and four drill helpers on each shift. The drilling and timbering of the enlargement and the placing of the crown bars was done by an average crew of one foreman, six drill runners and timbermen, and three or four helpers on each shift. The mucking crew for the heading and enlargement consisted of a foreman and 25 or 30 laborers on each shift with a tramming equipment of three mules and 10 to 12 one-ton cars. About 100 yd. of rock in place was excavated per day. Although a low-grade explosive will usually break soft or fractured rock to better advantage, 60% dynamite was used here in order to reduce the volume of smoke. No means of ventilation was employed other than that afforded by the use of compressed air, and the atmosphere became decidedly close during the last month before the heading was holed.

The tunnel arch above heading level was concreted in 5- and 10-ft. rings, depending on the nature of the ground. In heavy ground the posts supporting the crown bars cannot be removed with safety to leave a 10-ft. span and in such cases only 5-ft. rings were put in. Steel centers in two sections bolted together in the center, resting on blocks at the haunches and supported by posts, were used. Form lagging consisting of beveled strips 3x4 in. and 5 ft. long, dressed on three sides, was laid on the centers as the concrete progressed toward the center of the arch. Forms were left in place until the concrete had set 6 days. The space between the required extrados and the roof lagging was filled with concrete

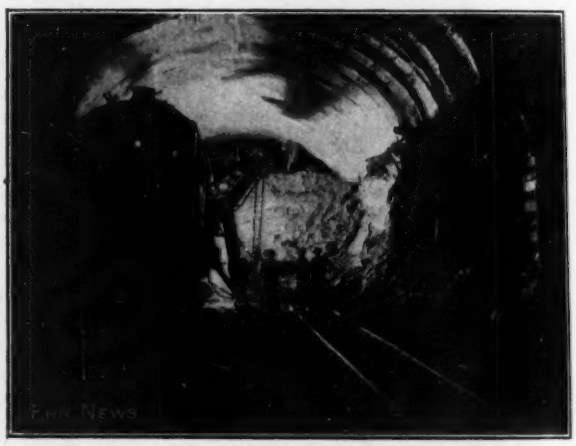


FIG. 12. REMOVING BENCH WITH SHOVEL; EAST SIDE TUNNEL, PROVIDENCE

from the haunches to the No. 2 bars, then as specified the space over the center of the arch was packed with rock. Concreting was done by the day shift and the packing at night.

Concrete was mixed on the surface, poured into a chute

at the shaft, and hauled up the tunnel grade by mules. It was then dumped on sheet-steel plates and shoveled into the arch, care being taken to equalize the load on each side. The concrete was kept about 150 ft. behind the enlargement excavation. Blocks were set in the ends of each ring and under the haunches to form a key. The average concrete force consisted of a foreman and seven men mixing on the surface, a mule boy, and a foreman with eight men and a spader to shovel into the forms. Four men set the ribs and built the housing.

BENCH AND SIDEWALL—The work underneath the Carr property was finished, so that the core could be removed, at about the same time the main tunnel arch was completed. This enabled a No. 20 Marion steamshovel to be brought in through the west portal and set up without delay east of the shaft. This was done early in September, 1913. It was operated by compressed air from the west-portal plant. No reheater was used.

The 3-yd. cars operated on Benefit St. were lowered down the shaft to subgrade, and thence hauled by electric locomotive to the bench.

The bench stood a trifle more than 12 ft. in height and was broken by a line of four holes extending across the tunnel and fired simultaneously. The holes were drilled to a depth of 2 ft. below subgrade, and chambered at the bottom before the final charge was inserted. In order that the long drills might be used, it was necessary to obtain clearance for them under the arch by excavating a trench 4 to 5 ft. deep along the line of holes. About 10 ft. of bench was removed at a blast, requiring 50 to 70 lb. of 40% dynamite. The lower grade of explosive could be used then when there was plenty of ventilation through the tunnel.

It was important that the least necessary amount of powder be used, in order to minimize damages to property on the surface from concussion; it was also essential that the rock be broken to the neat lines of the tunnel only to prevent undue shattering of rock underlying the haunches and skewback. Where the ground was broken out under the haunches the arch was posted until the concrete sidewall reached that point. Drilling was done by a crew of ten men including four drill runners and four drill helpers. In addition to the shovel engineer and cranesman, a force of six men took care of the pit and track and did what mucking was necessary. Work was being done in the day shift only.

As soon as the shovel advanced a sufficient distance to give it a reasonable amount of space in which to back away from the blasts, the excavation and concreting of the sidewalls was commenced. This work was kept at a distance of about 150 ft. behind the shovel. The sidewall forms were held in place by a series of steel uprights on each side, which rolled along a rail laid close to the wall. These uprights were held firmly at the bottom by bracing the rail and their tops by steel struts extending across the tunnel between them. The whole framework thus formed could be moved along the tunnel at will. The struts across the tunnel served also as supports for the trolley wire required for the operation of the locomotive to and from the shovel.

Sidewall sections were excavated in 16-ft. lengths, care being taken not to have sections adjoining or sections opposite open at the same time. The concrete was mixed on the surface, hauled up the tunnel by the empty muck trains and dumped on a sheet-steel plate, from which it was shoveled into the wall. The wall was brought up to the duct line and after a set of 12 hr. the conduits were waterproofed and laid in place, whereupon the concrete was finished to within 6 in. of the bottom of the arch. After 24 hours the last 6 in. of concrete was rammed in place and wedged to form a tight key. The sidewall excavation crew consisted of a foreman, four drill runners and ten men; the concrete crew underground consisted of a foreman, two carpenters and 12 men. The total excavation of bench and sidewall was about 140 yd. in place per day, the average progress being between 60 and 70 ft. per week.

APPROACHES—Work on the approaches and the 75 ft. of cut-and-cover tunnel at the east approach was commenced early in the spring of 1913. The work on the approaches consisted in the construction of the usual concrete retaining-walls, excavation for which was made in trenches on account of buildings and other property adjoining. The retaining wall at the west approach was faced with brick to match the portal. The east portal is a simple parapet and coping with panels over the arch, and a steel fence running across the top and down along the retaining-walls terminating at the ends of the approach in a combination lamp and trolley pole on either side. In event of continuing the tunnel to the Seekonk River (City subway plan), the retaining walls at the east portal must be rebuilt.

The 75-ft. of tunnel arch adjoining the east portal which was excavated by the cut-and-cover method underlies Fones Alley, and therefore being subject to live-loads, was reinforced. There is no particular difficulty connected with reinforcing the arch of a subway or tunnel constructed by the cut-and-cover method, but where this is attempted underground the cost is considerably increased on account of the difficulty of shoveling concrete between the rods in more or less cramped quarters. The greater part of the excavation from the east approach and cut-and-cover portion of the tunnel was trammed down through the tunnel to the shaft. Until the heading was holed through, this material was teamed away for land filling a mile away near the Seekonk.

The last bench shot was fired on Feb. 27, and at that time, there still remained 300 ft. of sidewall to be excavated and concreted. The contract work, which included the construction of the tunnel complete to subgrade, ready for ties, rails and ballast, was practically finished April 1. Placing of ballast, track and overhead construction was begun by the Rhode Island Co., April 6. The rock ballast will have to be teamed from freight cars to a temporary wooden platform at the west approach from which it will be dumped into narrow-gage cars and hauled into the tunnel by a small electric locomotive. It is expected that about two months will be required for all this work and for connections to outside tracks, paving in city streets and in the approaches. Cars should run through by the first of June.

The contractor was Joseph McCabe, who was experienced in railway and tunnel construction in both East and West. A. D. McDonald was the Contractor's Superintendent on this work. The maximum engineering force, in addition to the Division Engineer, consisted of the Resident Engineer, W. H. Mulgrew, an instrument man, a rodman, a chainman and three inspectors. The estimated total cost, including property, will be about $700,000.

Field and Office

Underpinning a Settling Bridge Pier

By Pusey Jones*

In constructing the extension of the Georgia Coast and Piedmont R.R., from Darien, Ga., to Brunswick, Ga., it was necessary to cross the Altamaha River and its branches. The Federal government required a drawbridge over the Darien River or north branch of the Altamaha, giving two 100-ft. openings. The foundations of this bridge consist of two end piers and one center or pivot pier. The pivot pier was completed the latter part of July, 1913.

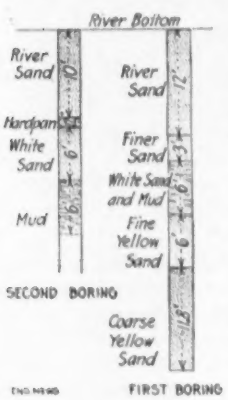


Fig. 1. Borings at Site of Darien River Pier

This pier is 36 ft. high, 25 ft. in diameter at the top and slopes down on a batter of ½ in. to the foot. The foundation consists of 122 wooden piles driven in sand. The original borings showed a good river sand for 12 ft.; finer sand mixed with pebbles for 3 ft.; a fine white sand with traces of mud for 6 ft.; a very fine yellow sand for 6 ft.; coarse yellow sand for 11.8 ft. The piles were driven very hard, the penetration being an average of 13.2 ft. These piles were cut off 2 ft. above the river bed with a beam saw, and surrounded with a $\frac{3}{16}$-in. steel form which was sunk into the bed of the river about 6 ft. It was impossible to sink it any further on account of old timber in the river bed.

This steel form, which reached above water level, was filled with concrete by means of a bottom-dump bucket, lowered through the water, which was 19 ft. deep at high water. The bucket was not dumped until it rested on the bottom. A wooden form was used for the concrete above water. All of the concrete was the same mixture, 1:3:5.

The erection of the steelwork of the bridge started in August, but had not proceeded far before it was discovered that the top of the pier, which had been level, was about 1¾ in. lower on the south side than on the north side. Work was at once suspended on the bridge. A fine wire was stretched between the ends of the falsework for the bridge which was built on the fenders, and daily observations were taken with an instrument. The difference in level was hardy perceptible from day to day, but the pier moved horizontally on top at the rate of from $\frac{1}{16}$ in. to ⅛ in. a day, which indicated that the settlement was on one side.

A diver was employed to examine the concrete in the foundation on the theory that the piles were working up into the concrete. He found concrete that had to be chipped to get a sample, and which showed no signs of honeycomb. A new boring was taken on the weak side, which gave the following results: a good river sand for 10 ft.; hardpan for 1 ft.; fine white sand for 6 ft., a soft mud, which was penetrated for 6 ft. without getting out of it (see borings on Fig. 1). These varied considerably from the original borings, and seemed to indicate that the river bed varied under the pier, and that the fine white sand in which the bases of the piles rest, is a water-bearing sand and consequently unstable. The settlement continued and it was decided that it would be necessary to reinforce the foundation to stop it.

Thirty-five 65-ft. wooden piles were jetted and driven around and close to the pier at intervals of about 2 ft. 6 in., to an average depth of 38 ft. It was necessary to jet these piles, as it was impossible to drive them through the fine white sand without breaking them. A coffer-dam of 14-in. arched-web Lackawanna sheet-steel piles, 40 ft. long, was built as shown in Fig. 2. This driving around the pier, especially that of the reinforcing piles caused the pier to settle badly as shown in Fig. 3, and bore out the original conclusion that the foundation piles were in an unstable material.

The coffer-dam was pumped out and the reinforcing piles cut off 3 ft. above the river bed. The steel form was removed from around the pier, and the concrete

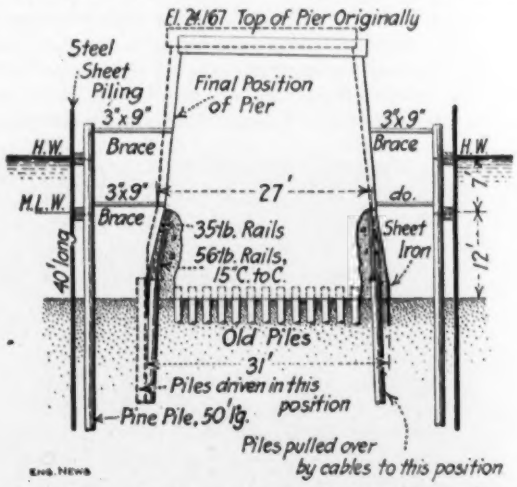


Fig. 2. Section through Pier, Darien River Bridge, Showing Settlement and Condition after Repair

around the pier was cut away for about 3 ft. and to a height of about 3 ft. above the top of the piles. The piles were then pulled and jacked under this ledge, using a water jet to loosen the sand in front of them. They were held in this position with four strands of ¾-in. steel cable, and were then surrounded with a steel form which was filled with concrete of a 1:2:4 mixture up to a level with the top of the piles.

The concrete in the pier was then cut away for a thickness of not less than 18 in. up to the low-water

*Chief Engineer, Georgia Coast & Piedmont R.R. Co., Darien, Ga.

COST DISTRIBUTION, REINFORCEMENT PIER "C", DARIEN RIVER BRIDGE

Amount	Kind of work	Equipment	Material	Labor	Total
	Assembling equipment	157.57	902.93	660.77	1,721.27
	Removing fender	47.53	42.08	128.23	217.84
35 y.p. piles	Driving reinf. piles	123.84	205.07	318.90	647.81
	Cutting reinf. piles	15.99	11.67	65.21	92.87
33 y.p. piles	Pulling under reinf. piles	6.46	72.26	170.65	249.37
29 y.p. piles	Falsework for coffer-dam	21.46	114.50	46.94	182.90
	Bracing coffer-dam	22.46	62.91	69.50	154.87
	Waling coffer-dam	62.92	96.30	148.74	307.96
130 sheet piles	Driving sheet piles coffer-dam	257.59	4,291.96	717.16	5,266.71
Dry 686 hr.	*Pumping coffer-dam	587.62	963.00	2,454.28	4,004.90
130 sheet piles	Pulling sheet piles	218.93	171.47	1,417.85	1,808.25
	Removing steel form	13.99	8.85	150.85	183.69
40 nights	Electric lighting		107.50	20.20	127.70
135 cu.yd.	Chipping foundation	34.68	23.15	306.25	364.08
36 cu.yd.	Chipping top concrete	9.00	23.55	294.80	327.35
163 cu.yd.	Reinf. concrete foundation	104.99	1,214.57	1,051.69	2,371.25
48 cu.yd.	Reinf. concrete top	98.92	342.22	313.17	754.31
	Removing falsework	34.69	7.26	117.79	159.74
	Redriving fender	122.38	222.66	608.79	953.83
	Totals	1,941.02	8,893.91	9,061.77	19,896.70
	15% to contractor				2,289.69
	Grand total				22,186.39

* Pumping was very difficult owing to the constant variation in depth of the water together with the varying direction of the tide. It was necessary to caulk joints with sawdust and cinders with every change in tide, making the cost of pumping excessive.

level. It was not the original intention to cut out so much of the pier, but the concrete which had been laid under water was not considered strong enough to carry the desired load to the new piles. Three rows of 35-lb. rails were laid around the pier, spliced on top of the piles. Upright pieces of rail were laid around the pier about 15 in. c. to c. A wooden form was erected and filled with 1:2:4 concrete to a level with the last ledge, two more rows of rails having been laid around the pier horizontally at 2 ft. and 6 ft. above the top of the piles.

This completed the reinforcement. The steel piles and

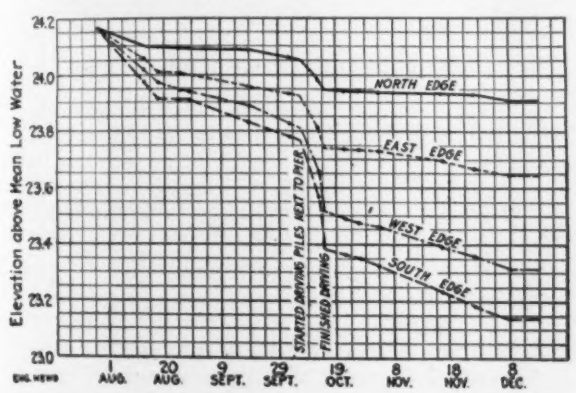


FIG. 3. SETTLEMENT DIAGRAM, DARIEN RIVER BRIDGE

the wooden form piles were pulled, and the bridge fender, which had been removed to allow the work around the pier, was reconstructed. No further settlement of the pier has been noticed since the placing of the first layer of concrete around the reinforcing piles, the friction against the pier apparently being enough to hold it.

Fig. 2 shows the pier dotted in its original position. The solid lines show the pier in the position it had assumed when the settlement stopped. It also shows the reinforcement and the design of the coffer-dam. The top of the pier was chipped off, and brought to its proper elevation with new concrete reinforced with old rails.

One of the most interesting parts of the work was the opportunity it gave for the inspection of concrete that had been laid under water. The concrete was not good, though there was no tendency to flow or fall out. The sand and stone were held together largely by friction, the cement having separated in layers. As stated above, the concrete was well mixed, placed in a bottom-dump bucket, lowered through the water, and the latch pulled after it

FIG. 4. SIDE OF PIER SHOWING CONCRETE REMOVED VERTICAL REINFORCING RAILS AND CIRCULAR RAILS OVER PILES

rested on the bottom. It was not possible to pull the latch until it rested on the bottom, thus taking the weight from the latch lever. This should have produced as good concrete as can be laid under water, but many of the stones could be pulled out with the fingers, and the cement had separated in many places in layers. The inspection seemed to justify the conclusion that concrete placed under water should be a richer mixture than that placed above water, so as to allow for a large percentage of loss due to wash. Fig. 4 is a photograph of the concrete after the ledge had been cut, and shows also the reinforcement in place.

The cost of the reinforcement together with its distribution is given in the accompanying table. The work was done by the Beasley Contracting Co., of Savannah, Ga., on a force account basis. The field work was in charge of R. de Charms, Jr., Assistant Engineer, to whom the writer is indebted for the compilation of the cost data contained in this article.

Establishing Street-Tree Lines in Abilene, Kan.—As a preliminary to enacting an ordinance fixing lines for trees in the streets of Abilene, Kan., a tree survey was made and mapped. Measurements were taken at street intersections of the distance between property lines and existing street-tree lines. Existing trees were plotted on a blue-line map of the city, using a different color of ink to denote each kind and size of tree. By means of this map, tree lines best fitting existing conditions (if those conditions were satisfactory) were determined and adopted as the fixed tree line. Like many other towns, Abilene had not seen the importance of uniformity and symmetry in street-tree planting. The result was general confusion of tree lines. Such matters demand municipal regulation. (Kenyon Riddle, Engineer-Manager, Abilene, Kan.)

Measuring Sewer Flow by a 26-Ft. Sharp-Crested Weir

In connection with the experimental sewage-treatment plant on Jamaica Bay, Brooklyn, N. Y., it was essential to determine the infiltration of groundwater and the maximum and minimum flow of sewage in a very large trunk sewer, serving a population of about 178,000, and having an average daily flow of over 18,000,000 gal. (28 cu.ft. per sec.). To obtain these data a weir was constructed, and the gage height automatically recorded day and night for each day of the week, for a period of several weeks.

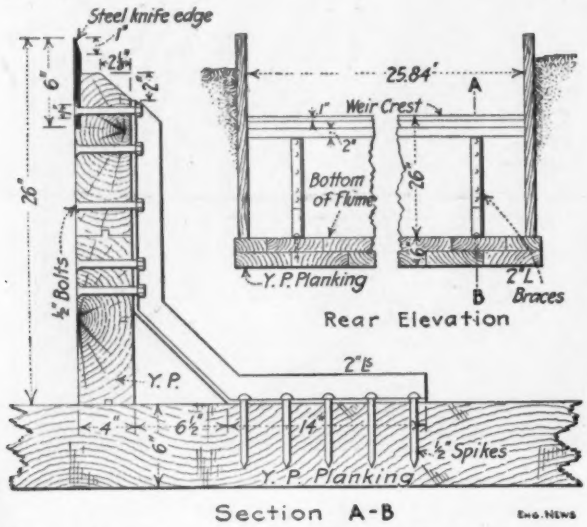


FIG. 1. DETAILS OF A SHARP-CRESTED WEIR, 25.84 FT. LONG, WITH END CONTRACTIONS

The weir was placed in the outfall sewer, below the disposal plant, where the sewer is in the form of an open plank-lined flume through the salt meadows bordering Jamaica Bay. The details of the weir are shown in Fig. 1. It was sharp crested, with end contractions suppressed. The crest length was 25.84 ft. and the height 2.17 ft. The head on the crest when not affected by storm or snow water varied from 0.362 ft. (4:30 a.m., Friday) to 0.543 ft. (3:05 p.m., Tuesday). Fig. 2 shows the weir in the course of construction, and Fig. 3 the weir in operation. A horizontal edge on the weir was obtained by accurate work with a wye-level, adjustments being made from the slotted bolt holes shown in Fig. 2, and finally by filing off very small irregularities.

The device for recording the heads on the weir is shown in Fig. 4. It consisted of an automatic water-stage recorder, or regulation tide-gage, with a specially designed apparatus for magnifying the gage heights. The ball float was placed over a "Bazin pit," placed just outside of the channel and about 16 ft. upstream from the crest of the weir. The pit was connected with the flume through a 3-in. iron pipe, 3 ft. long, laid on the floor and

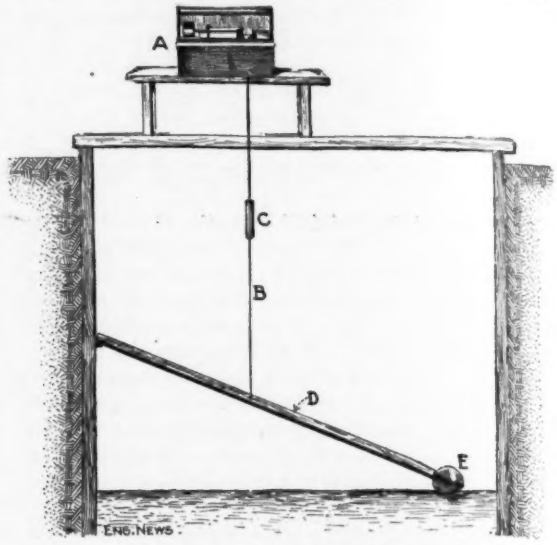


FIG. 4. DEVICE FOR RECORDING HEAD ON WEIR

perpendicular to the side of the approach channel to the weir. There was a 6-in. wall between the pit and the channel.

The zero of the register was determined by means of a hook gage and a wye-level. The correction for slack motion of the register was determined by hook gage to be ½ of 1%. Fig. 5 shows the recording gage set over the "Bazin pit."

Bazin's formula for suppressed weirs with velocity of approach, $Q = m\,L\,h\,\sqrt{2\,g\,h}$ was used to compute flow. It is suggested, however, by the engineers in charge, that

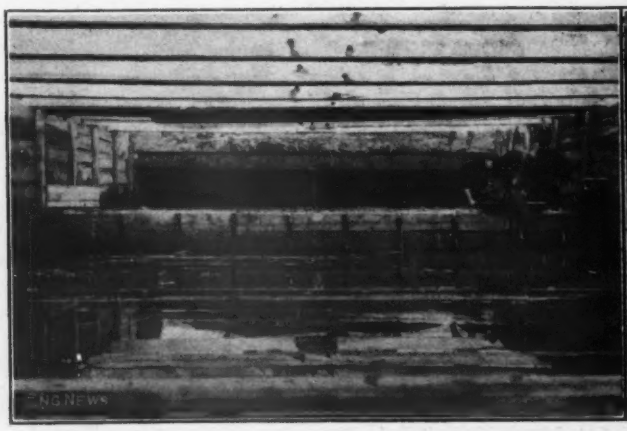


FIG. 2. WEIR IN PROCESS OF CONSTRUCTION

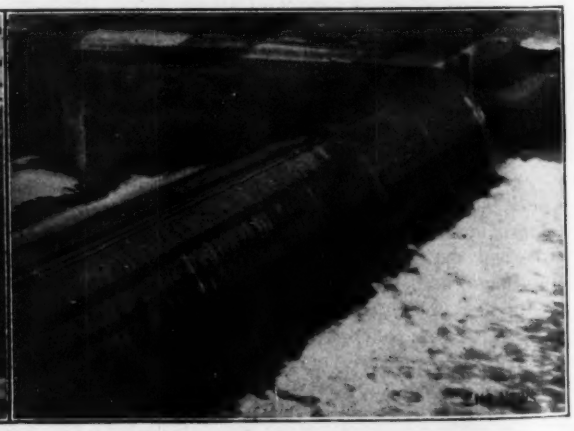


FIG. 3. WEIR IN USE

Hamilton Smith's formula $Q = 3.29\ L\ H^{\frac{3}{2}}$, for weirs of great length, may give more accurate results. The average total flow for 24 hr., as indicated by the gage records, was 18,123,000 gal.

This is believed to be the largest experimental sharp-crested weir ever built. The work was under the supervision of Edwin J. Fort, Chief Engineer of the Bureau of Sewers, Borough of Brooklyn, New York City, and George T. Hammond, Engineer of Design.

Founding a Building over Coal-Mine Workings

By Geo. E. Stevenson*

The problem of securing a foundation for the large six-story Miller Bros. Bldg., to be erected on Wyoming Ave., Scranton, Penn., was solved recently by constructing concrete-filled pipe columns under the building.

This matter was submitted to us by T. M. Miller Co., in August, 1913, who asked us to make a report upon the condition of the mines beneath the property and recommend a method of securing the foundation against any danger from mine settlement.

Our investigation established the fact that the Big Vein (Fourteen-foot Vein) was the first vein below the surface and it had been mined out by the Lackawanna Iron & Coal Co., many years ago, prior to the first mining law requiring surveys and maps of the mines. The mineral rights beneath this property were acquired by the Scranton Coal Co., about 1900. The deeds for the surface contained the following reservations:

> Excepting and reserving, however, to the party of the first part, all coal and minerals beneath the surface of and belonging to said land, with the sole right to mine and remove the same by any subterranean process incident to the business of mining; and also the sole right of passage through or under the said land to mine and remove the coal and minerals from other lands by any subterranean process without thereby incurring, in any event whatever, any liability for injury caused or damage done to the surface of said land or to the buildings or improvements which now are or hereafter may be put thereon, and the party of the second part for himself, his heirs, executors, administrators and assigns, doth hereby expressly release and discharge forever the said party of the first part, its successors and assigns, and all persons who may have derived title to said coal or other minerals from the said party of the first part, of and from any liability for any injury that may result to surface of said premises, or anything erected or placed thereon, from the mining or removing of said coal or other minerals. Provided that no mine or air shaft shall be intentionally opened or any mining fixtures established on the surface of said premises.

The mines beneath the property are tributary to the Pine Brook Colliery, operated by the Scranton Coal Co., and situated about 700 ft. northerly from the lots in question.

The veins of coal originally in place beneath the property are:

1. The Big or Fourteen-foot Vein, about 14 ft. in thickness over all. The top of the Big Vein was found to be about 14 ft. below the sidewalk line in front of the proposed building.

2. The New County Vein, next below the Big Vein. There were no openings or boreholes in the vicinity in this vein to enable us to determine its thickness or minability; probably it is not more than 2 ft. in thickness and has not been, or is it now, considered a minable vein in the vicinity.

*Of Stevenson & Knight, Engineers, Connell Bldg., Scranton, Penn.

Fig. 5. Recording Gage Set over "Bazin Pit"

3. The Clark Vein, 117 ft. below the Big Vein, about 150 ft. below the surface. It was mined over on first mining many years ago and about 35% of the coal left in pillars. The Clark vein is about 7 ft. thick.

4. The Dunmore No. 1 Vein, about 65 ft. below the Clark Vein, 215 ft. below the surface. The vein carries about 3 ft. of coal and 1 ft. of impurities. It was mined over on first mining, leaving 38 to 40% of the coal in pillars, and the refuse rock was packed back in the chambers, partially filling them and reinforcing the pillars.

5. The Dunmore No. 2 Vein, 61 ft. below the Dunmore No. 1, and about 276 ft. below the surface. It was mined over on first mining, leaving 38 to 40% of the coal in pillars, and the refuse rock was packed back in the chambers. This vein contains about 4 ft. of coal and 2 ft. of impurities.

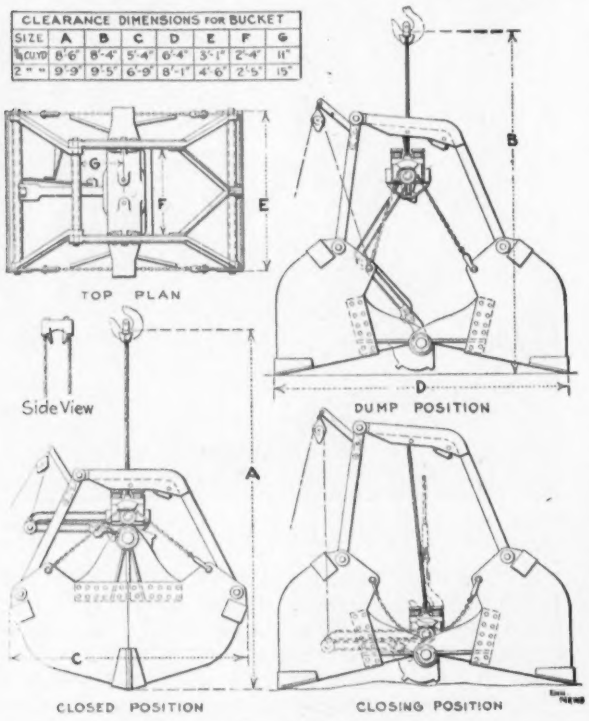
6. The No. 3 Dunmore Vein, about 44 ft. below the No. 2, or 320 ft. below the surface. The vein carries about 3 ft. 2 in. of coal and 1 ft. 4 in. of bony coal. It was mined on first mining leaving 38 to 40% in pillars, and the refuse rock packed in the chambers.

Our investigation in the Big Vein demonstrated that the maps in existence, showing the early mining, were indefinite and uncertain, and we found only a small portion of the mined-out area accessible to inspection beneath the

surface. We made careful surveys of all the openings that we could enter and found most of the openings caved and settled between the pillars.

A shaft was sunk within the foundation walls of the building near the center, and apparently came down on the edge of a pillar and the edge of the caved portion of a chamber. At this point, the vein showed no rock roof. Where accessible in the mines, the top coal had been left up for a roof.

We were of the opinion that the pillars could not be removed from this caved territory under present conditions of mining without incurring greater expense than would be warranted on the part of the operating company, but the uncertainty and lack of stability of the foundation beneath the building to the bottom of the Big Vein made it necessary for us to devise some method of securing support for the building on the bottom rock of the Big Vein. The building was to have steel frame, concrete floor, and


CLEARANCE DIMENSIONS FOR BUCKET
SIZE A B C D E F G
½ CU YD 8'-6" 8'-4" 5'-4" 6'-4" 3'-1" 2'-4" 11"
2 " " 9'-9" 9'-5" 6'-9" 8'-1" 4'-6" 2'-5" 15"
TOP PLAN
Side View
DUMP POSITION
CLOSED POSITION
CLOSING POSITION

THE BROSIUS SINGLE-HOIST BUCKET IN DIFFERENT OPERATING POSITIONS

curtain walls. It was to be 60 ft. in width, 157 ft. 7 in. in length, and six stories in height.

We finally devised the following scheme for insuring a secure foundation on the bottom rock of the Big Vein. Five lines of holes were drilled from the surface of the excavation for the basement walls to the bedrock of the Big Vein. An average section of the strata cut by these boreholes was about as follows:

	Ft.
Wash consisting of hardpan and boulders	14
Coal	4
Dividing rock	5
Coal (left up for roof in first mining of this vein where there was not a good rock cover over the upper bench of coal)	4
Opening from which the coal had been mined	8
Fireclay underlying the bottom bench of coal	2
Sand rock	1 to 2

These holes were drilled until a firm footing was found in the sand rock. Steel pipes 12 in. in diameter were driven in the form of piles, and these were in turn filled with concrete. These lines of driven pipe were 14 ft. 10 in. on centers one way and 16 ft. 4 in. on centers the other way. Along the tops of these concrete-filled piles was constructed a reinforced-concrete beam.

While this method of securing a substantial and secure foundation is somewhat expensive, it offers, we think, the best solution of the problem where the vein is close to the surface and partly caved and inaccessible.

Simple Clam-Shell Bucket Attachable to Derricks and Cranes

A single-hook clam-shell bucket of comparatively simple construction, which can be attached to any stiff-leg derrick or crane with the ease of any ordinary dump bucket, was recently placed on the market by Edgar E. Brosius, contracting engineer, of Pittsburgh, Penn.

The hoisting rope passes down over sheaves carried on the crosshead and up to the lever arm above. The latch which locks the crosshead firmly to the center shaft of the bucket, through the medium of a tool-steel lip on the lower guide lever, is also situated on the crosshead. The latch-releasing lever requires but little pull on the trip line to open the bucket.

Before closing, the crosshead and bucket are locked together, so that the pull of the hoisting rope not only exerts a lift but is also transmitted to the bucket shells through the lever arms above. This results in a multiplied closing action. When the bucket is closed, or when the closing moment is equal to the weight of the bucket and load additional pull on the rope lifts the bucket as a whole.

The principal use for the bucket is on installations where a single hoist is used and where miscellaneous materials are to be handled. The bucket can be quickly attached or detached and thus used at frequent periods at irregular intervals throughout the day, to take the place of the dump bucket, which must be filled by shoveling. It is particularly efficient in handling sand, gravel, crushed limestone, etc., and should make an economical tool for many contractors.

The buckets are made in four sizes, ¾-, 1-, 1½- and 2-cu.yd. capacity. The headroom required to operate the ¾- and the 1-cu.yd. bucket is 9 ft., and the 1½- and 2-cu.yd. is 10 ft. 6 in. At full opening, the ¾- and 1-cu.yd. buckets give a spread of 6 ft. 4 in., and the 1½- and 2-cu.yd. of 8 ft. 1 in.

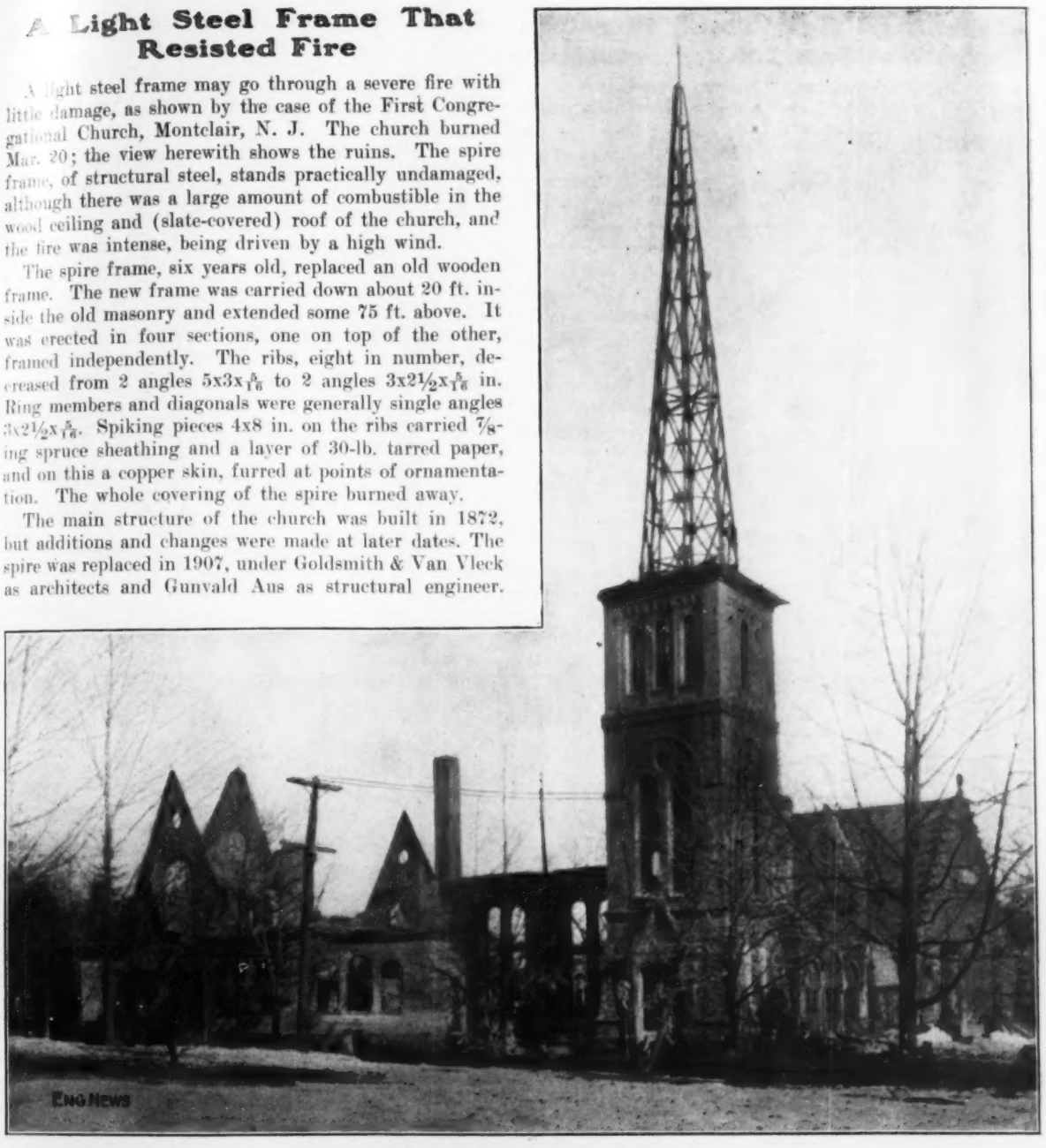
A Small Blueprinting Machine for use in offices where the demand for blueprinting is not large but sufficient to make a machine very convenient, has been placed on the market by the Revolute Machine Co., of 417 E. 93d St., New York City. The "Half-Moon" is built on the same principle as the Everett-McAdam machine, described in our issue of Nov. 15, 1906, p. 500. The main element is a revolving glass cylinder containing two mercury-vapor lamps. The machine will make a 32-in. print, printing occurring during a ¾-revolution of the cylinder. An electric motor drives the machine through a variable gear, which regulates the printing speed. A "Half-Moon" for use on a 110-volt direct-current circuit is listed at $350. The next larger blueprinting machine is the 42-in. Everett-McAdam, which is listed at $650, when equipped with a 7-ampere lamp, and $700 with a 15-ampere lamp. The largest machine is the 54-in. Everett-McAdam, listed at $875 and $925 when equipped with a 7- and 15-ampere lamp, respectively. The prices are for direct-current machines; alternating-current machines are somewhat higher.

A Light Steel Frame That Resisted Fire

A light steel frame may go through a severe fire with little damage, as shown by the case of the First Congregational Church, Montclair, N. J. The church burned Mar. 20; the view herewith shows the ruins. The spire frame, of structural steel, stands practically undamaged, although there was a large amount of combustible in the wood ceiling and (slate-covered) roof of the church, and the fire was intense, being driven by a high wind.

The spire frame, six years old, replaced an old wooden frame. The new frame was carried down about 20 ft. inside the old masonry and extended some 75 ft. above. It was erected in four sections, one on top of the other, framed independently. The ribs, eight in number, decreased from 2 angles 5x3x$\frac{5}{16}$ to 2 angles 3x2½x$\frac{5}{16}$ in. Ring members and diagonals were generally single angles 3x2½x$\frac{5}{16}$. Spiking pieces 4x8 in. on the ribs carried ⅞-ing spruce sheathing and a layer of 30-lb. tarred paper, and on this a copper skin, furred at points of ornamentation. The whole covering of the spire burned away.

The main structure of the church was built in 1872, but additions and changes were made at later dates. The spire was replaced in 1907, under Goldsmith & Van Vleck as architects and Gunvald Aus as structural engineer.



A Steel Spire Frame after Severe Fire

The timberwork of the main roof, and the heavy wooden ceiling below it, probably date from the time of original construction. Much interior work, including various ordinary wood-stud lath-and-plaster partitions of recent date, added to the amount of combustible.

Fire-Killed Pine and Spruce for Poles—Tests of the strength of fire-killed lodgepole pine and Engelmann spruce have been made by the Forest Service to fix the value of these materials for use as telephone and power poles [see Department of Agriculture bulletin, No. 67 B, by N. D. Betts and A. L. Heim]. The two species in question are of little use for lumber, and in any case, the checking resulting from the fire influence spoils the material as saw timber. Poles about 25 ft. long, 7-in. top diameter, were tested in bending under an arrangement simulating the support and loading of a telephone pole. Both the ultimate bending strength and the percentage of shear failures of the fire-killed timber were satisfactory. For example, 20 tests of fire-killed lodgepole pine (standing 10 years) showed a modulus of rupture ranging from 2200 lb. to 7500 lb., averaging 5500; while 22 air-seasoned lodgepole pine poles cut green ranged from 5200 to 9500, averaging 7700; fire-killed Engelmann spruce poles ranged from 2200 to 6100, averaging 4400. Comparative tests of the two woods against Western red cedar showed air-seasoned lodgepole pine to be superior to the cedar (a commonly used pole timber) in mechanical properties, and fire-killed lodgepole pine about 80 per cent. as strong as cedar For elastic-limit stresses, however, the three timbers showed about equal.

Erecting High Steel Wireless Towers at San Juan, Porto Rico

Several interesting problems were presented in the erection of two 300-ft. steel towers at the United States naval radio station at San Juan, Porto Rico. The towers are constructed largely of steel angles and, considering their height, are very light. Considerable troublesome riveting had to be done on the job, as the material was shipped knocked down, in order to avoid damage in transit.

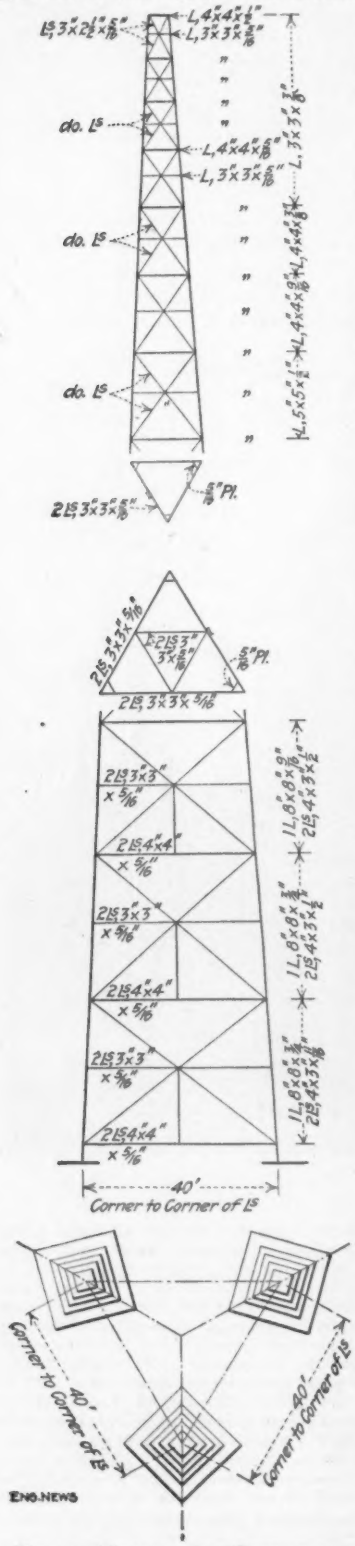


FIG. 1. PLANS AND ELEVATION OF TOWER

The design of the towers is shown in Figs. 1, 2 and 3. Each tower is 300 ft. high, with a base 40 ft. on a side, forming an equilateral triangle in plan. Structurally it is divided into 15 stories. Each tower leg is supported on an anchored shoe on a concrete footing.

Each tower has three legs having a continuous batter of about 1 to 20. They are connected in the three faces by continuous bracing composed of horizontals at each story level, intermediate laterals between columns for stiffening them, and cross diagonals. Hangers attached to the intersection of the diagonals extend down to support the horizontal strut just below.

The legs in the lower four stories are built of one 8x8 x¾-in. and two 4x3 x$\frac{11}{16}$-in. angles, as shown in the design drawings, decreasing in section to one angle 3x3x⅜-in. at the top. The main horizontal struts are two angles except at the upper three tiers; while the intermediate laterals are made up of two angles 3x3x$\frac{5}{16}$ in. for the first four tiers, and one angle for the rest of the way. The crossed diagonals are single angles, 4x4x⅜ to 3x3x$\frac{5}{16}$ in. in cross-section. The connections

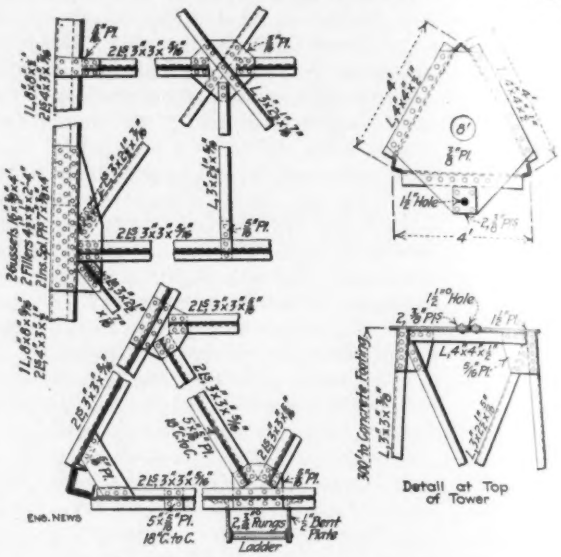


FIG. 2. DETAILS OF STEEL DESIGN

are made by gusset plates in the planes of the tower faces; while horizontal tie plates just inside the legs at each story level connect the horizontal struts attached at that point.

A peculiarity in the design from the standpoint of easy erection lies in the absence of a support for the wind

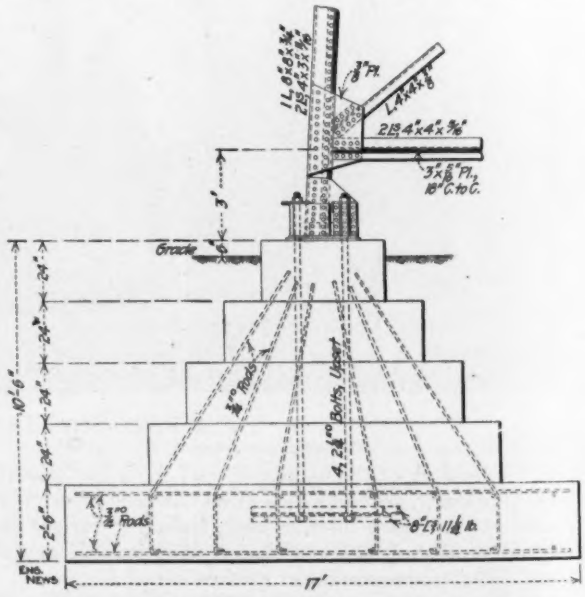


FIG. 3. ELEVATION OF A TOWER-LEG FOOTING

bracing at the top of a completed panel. The unsupported span varies from 40 ft. at the base to 8 ft. at the top, and although sufficiently rigid to resist wind pressures, it was not strong enough to sustain the weight of erection tackle. This difficulty was overcome by the device shown in Fig. 4. A 6x6 wood auxiliary strut was placed under the wind bracing and kept from slipping by a

notch which fitted snugly around the lower flange of the lower angle of the bracing. The other end of the strut was fastened through the medium of a block and falls to the middle point of the diagonal bracing below. The auxiliary strut was thus held tightly against the horizontal strut, which it stiffened. Had the distance between the horizontal and the diagonals below been the same for each tier, the lower end of the auxiliary strut could have been supported directly on the center of the diagonal bracing, thus doing away with the block and falls. This distance, however, decreased constantly as the work advanced, making the method used more practicable.

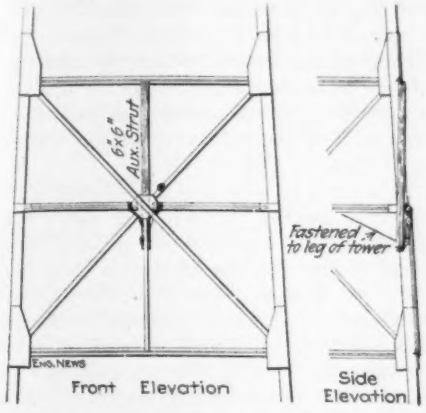
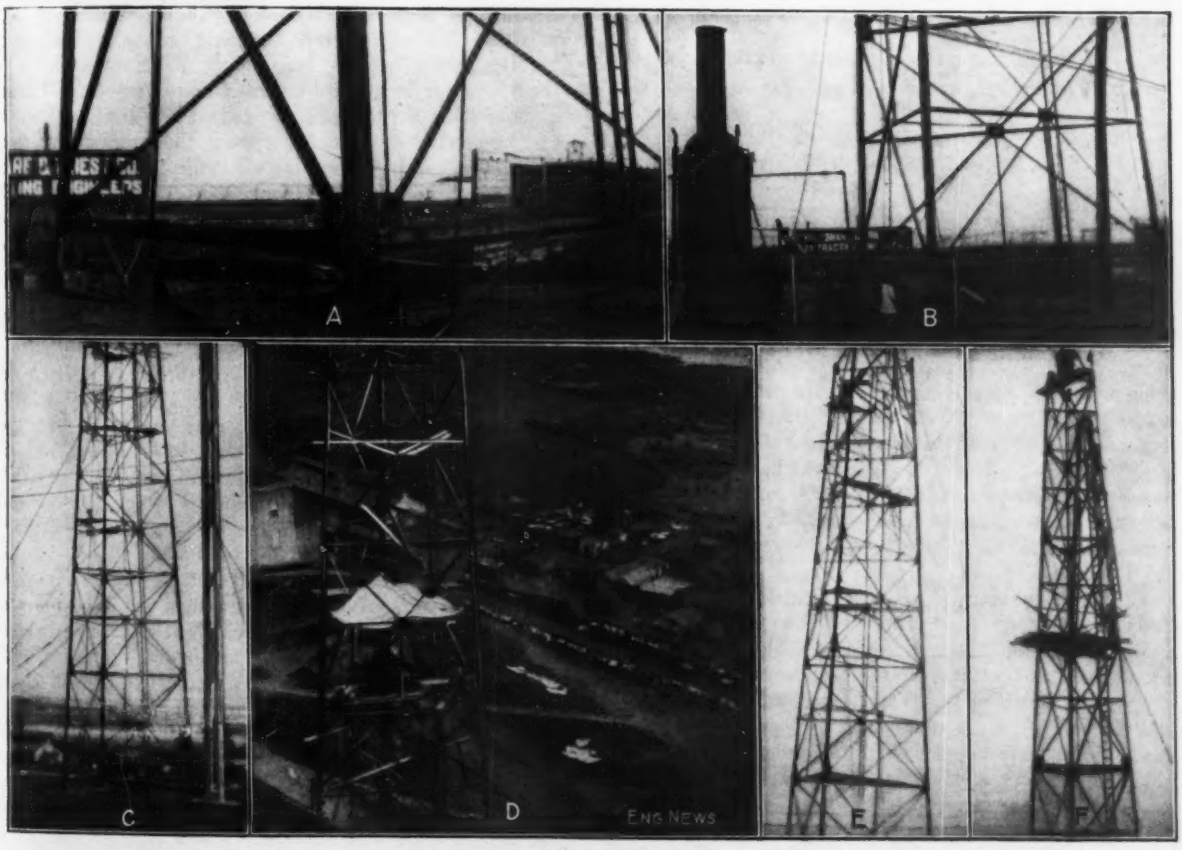


FIG. 4. THE AUXILIARY STRUT TO SUPPORT ERECTION TACKLE

FIG. 5. THE ERECTION DUTCHMAN IN POSITION ON TOWER



GENERAL VIEWS OF THE SAN JUAN WIRELESS TOWERS DURING ERECTION

A—Method of anchoring towers to the concrete footings.
B—Base of tower, showing location of hoisting engine.
C—Tower and mast which it replaces.
D—View of tower taken from present mast.
E and F—Upper panels of tower, showing erection dutchman in place.

The hoisting and erection were done by a dutchman, consisting of a 6x8-in. stick 35 ft. long, fastened at right angles to another 6x8, and braced thereto by two 2x6-in. diagonals. The dutchman leaned away from the axis of the tower, being guyed to the steelwork, as shown in Fig. 5.

The dutchman was first set up on the ground, from which point it erected the steelwork to the first tier. It was then lifted to this tier, which had been braced by the auxiliary struts mentioned, and placed the steelwork of the second tier. On each tier the dutchman was moved three times, erecting a third of the steelwork of the panel from each location.

The heaviest pieces to be handled were the leg sections, whose maximum weight was about one ton each. These lengths were shipped built-up except for the gusset plates, which had to be riveted after the column was set. All field connections are riveted.

After the work had advanced a certain distance, and the steelwork became less heavy, it was possible to use a lighter dutchman, and another one was set up consisting of a 6x6-in. stick about 30 ft. long. The dutchman is visible on the tower in views *E* and *F*. View *F* shows the work advanced to a point where the dutchman was abandoned, and the remaining steelwork placed by hand.

The work has been carried forward since Jan. 15, 1914, and is now complete. The Snare & Triest Co., Woolworth Building, New York City, were the contractors.

Notes on the Use and Care of Engineers' Instruments

By D. N. Showalter*

The young engineer, fresh from college, when first out on a survey, is sometimes confronted by difficulties due to his inexperience in small matters. Minor details and methods of actually doing work are omitted from both textbooks and college lectures. The following notes are intended for the young man whose field experience has been limited:

The Transit—On a construction job, the transit should have a small wall box made with an inside latch of wood so that the transit may be set in and held securely even when the door is opened. This case should be reasonably dust-proof. Parts of the transit should be occasionally oiled with the best grade of sewing-machine or "3 in 1" oil. The finer the transit bob string, the less the bob will be deflected by wind. A fine grade of oiled-silk fish line makes a good string. A small piece of leather threaded into the bob string saves time in adjusting the length of bob.

On foggy or rainy days, a sun shade should be used to keep the object grass clear. On very bad days, it will have to be removed and the object glass wiped at intervals. If the instrument is set on a point at the time, the wiping must be very carefully done.

It is well to have a small oilcloth hood to put over the instrument, if it has to be left standing any length of time on a sleety day. The tripod legs should be kept quite tight where fastened to the head. In setting up an instrument the young engineer will soon learn to grasp two legs, and kick the third one out into position. On a construction job where great accuracy is required, and time is not so essential, the instrument should have a double ¾-in. magnifying glass, which is quite powerful. On ordinary survey work a large single glass is far preferable.

The Level—For construction work, the level tripod should have quite firm, heavy legs, since it sometimes has to be used on windy days, and never has to be carried any great distance. If the level be a modern one, with a slow-motion screw, it can be used as a transit, upon a pinch on certain kinds of work, by having a plumb-bob screw-eye put in underneath its center.

The instrument man should experiment to find out the sensitiveness of the level bubble, or, in other words, how many divisions on the rod a bubble division corresponds to, at a given distance. This will give him an idea of how accurately to level his instrument up for different classes of work.

Most wye levels have two points at the side of the wye, which may be sighted over with the naked eye for rod readings which are too close to be read through the lens. Unfortunately, these points are frequently not on the axis of the instrument so that the reading may be several hundredths in error. In damp weather, a spider-web cross hair will sometimes wrinkle up. The writer knows no remedy for this, except to postpone operations until the level is dried out enough so that it will give approximate elevations.

The Rod—For construction work, the writer is strongly in favor of a heavy Philadelphia rod, divided to hundredths of a foot. If much rough or dirty work is expected, it is well to have a flexible canvas rod tacked to a well seasoned, painted strip of board. Such a rod costs from a tenth to a third as much as an ordinary Philadelphia rod. On these canvas rods, the black hundredths are frequently somewhat narrower than the white hundredths, so that for very fine work they may not be quite accurate. It is sometimes convenient to have a rod made as above, but quite long, say 16 or 17 ft., and with a bolted joint in the middle. These canvas rods should be well tacked to their wood back or they are apt to wrinkle in damp weather.

It is also convenient to have a short or half-length rod on the job. Red flannel tacked on the edge makes this an excellent range pole for long distance transit work. A rod level is a great convenience on a construction job since frequently quarters are too cramped or there is too much wind to balance the rod. If a level cannot be had, a plumb-bob should be dropped at the corner for accurate work. Of course, great care should be taken that the end of the rod and the bench mark are clean, and that the top part of the rod has not slipped down.

Tapes—On construction work, the engineer's tape should be graduated to feet and inches. A tape may be obtained with the foot mark repeated at each inch, which will probably prevent a number of errors. A heavy surveyor's tape is out of place on a construction job, since it will not give accurate measurements unless it is supported for its entire length. A good light tape will weigh about 0.147 oz. per foot. For ordinary use, the writer favors a 75-ft. tape in a metal case. His next choice would be a 100-ft. one. If there is a second tape on the job, it should be a 50-ft. tape. For a tape of the above weight, a pull of 24 lb. will leave about 3 in. sag in 75 ft., which is equivalent to $^1/_{37}$ in. shortening in each tape length.

*Box 1252, Pittsburgh, Penn.

It is easy to experiment with each individual tape and plat a curve of sag and shortening for various pulls. For very accurate work, a spring balance should be used on the tape; but the engineer should learn to know just about how much pull to give a tape for accurate measurement. In winter work, a tape constantly gets wet and should be dried with waste, and polished with some good liquid metal polish. Only as a last resort should fine emery cloth be used on a thin tape. When the tape has been reeled up wet, it should be removed from the case, and the case well wiped out on the inside. Finally, the tape should be coated with vaseline, or a thicker and heavier grease. The engineer should, of course, keep on hand 6 or 8 ft. of broken tape, and a stock of rivets so that his tape may be mended quickly. When climbing around forms, and using a tape, it is often convenient to keep the case in the coat pocket, allowing the tape to run through one hand.

PLUMB BOBS—Plumb bobs are among the most used and most important instruments on a construction job. The engineer should have at least two accurate ones. The ordinary steel-pointed brass bobs sold by hardware stores are usually not accurate, nor do they come to a sharp point. A 10- or 12-oz. bob is a convenient weight to carry in the pocket, and may be used for most purposes. There should be one quite heavy bob, weighing from 17 to 20 oz. for use on high walls, etc. All bobs should be slender, brought to a sharp point, be a true cone, and should be equipped with a woven waxed fish line. The waxed line does not tangle so easily and is waterproof. The plumb-bob string should always be reeled up on a small wooden spool for carrying in the pocket. A small brass fish-line reel is quite convenient.

RULES—A six-foot folding rule is a necessity on a construction job, and the engineer should always have one in his pocket. The white rule may be seen a little more clearly with the transit, although a yellow one is usually a little cheaper. A rule can frequently be used as a rod in a pinch, and in lining up forms, etc., may be read vertically or horizontally.

AXES—Tastes vary greatly in regard to axes. For construction work, a 2½-lb. or heavier hatchet, with a broad head and comparatively narrow blade is convenient. If it has a hole drilled in the handle, with a leather thong loop, the rodman can carry it on his arm when climbing. It is also well to have the term "Engineer's Axe" burned in the handle, so that the axe will not go astray.

STAKES—There are four classes of stakes, viz.: important corner hubs, permanent stakes, temporary stakes, and nails. Corner hubs should be made of 3x3-in. oak, from 2 ft. to 3 ft. long; permanent stakes may be 1x2½-in. oak, 2 ft. long, and temporary stakes may be ⅞x2½-in. yellow pine, 15 in. to 2 ft. long. Nails are either 12-in. drift pin for use in hard frozen ground in place of stakes, or 10d to 12d nails, which may be driven in well compacted soil for a point which there is no possibility of needing more than once. Wooden stakes should be driven flush with the ground, and a tack put in the top. It is well to put a marker stake close by. A 10-lb. or 12-lb. sledge with a square end is convenient for driving stakes. Two 4- or 6-oz. tacks are large enough for most purposes. Stakes cannot be driven in frozen ground unless a hole is first made with a bar. If the bar is to be carried around, it should not be too heavy. A 1-in. bar of hard steel, 4 ft. long, diamond pointed, and weighing about 11 lb. is convenient.

MISCELLANEOUS ACCESSORIES—The engineer should keep himself supplied with marking line, which usually is hard twisted cotton cord, about $^{5}/_{64}$ in. in diameter, and is purchased in skeins by the pound.

Where dark forms or corners are to be inspected, an acetylene miner's lamp is quite convenient since it leaves the hands free for climbing.

Good marking keel is very hard to get. It should be of a brilliant brick-red color, and should be reasonably waterproof. In addition, it should be hard enough so that it can be easily carried, and will mark well on rough surfaces.

A yellow hexagon ⅜-in. pencil has innumerable uses in surveying on a construction job. It makes an excellent target for all sorts of transit shots since the yellow stands out prominently and may easily be bisected, and since the point leaves a permanent mark in the proper position.

It is convenient to have a rough plumb-bob tripod for setting over depressed points. The tripod may be 4 ft. or 5 ft. high, with a 6-in. or 8-in. hole in the head, and the bob cord should be fastened to a block resting on top. The bob string makes a good target, where it is necessary to catch depressed points. It is convenient to have a light wooden right angle with 4-ft. or 5-ft. legs, and also sometimes to have a wooden angle with movable legs. These are particularly useful in laying out concrete forms.

The engineer or rodman should have a small stone chisel which may be carried in the vest pocket, and which can be used for cutting bench marks, for cutting wire, nails, etc.

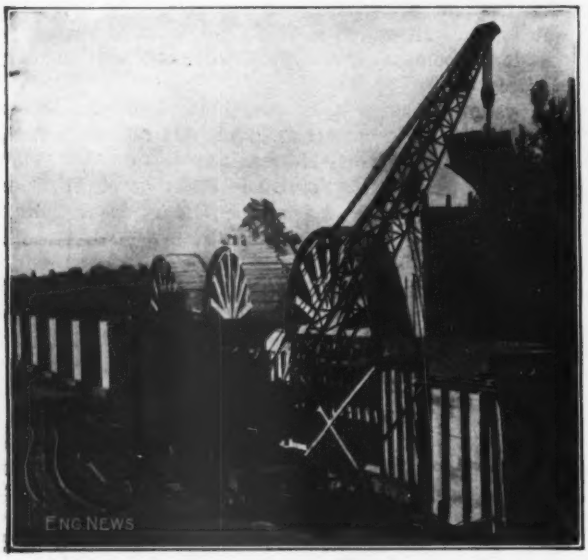
In checking contours or similar work with a hand level, it is convenient to have a stick about 5 ft. long, grooved at the top, in which to rest the level. This stick should also have grooved shelves at a height of 3 ft. or 4 ft., so as to be convenient for other than 5-ft. contours.

A good durable target may be made by cutting sections from a piece of white celluloid, and tacking it up with tar paper back of it. Such targets can be tacked up on the main reference lines of the job. For levels, it is very convenient to have an old rod nailed up vertically at some conspicuous place, and set accurately to elevation. The level may be turned on it from any point on the job.

NOTES

Denver Concrete Viaduct Soon to Begin—Work will start within a few weeks on the Colfax-Larimer Viaduct in Denver. This structure will be remarkable not only for its great size but also for its peculiar shape, being X-shaped, consisting of two portions crossing each other diagonally. The main portion starts at Federal Boulevard, in the line of Colfax Ave., and extends to West Colfax Ave., at Osage St., a length of 5544 ft. Crossing it at First and Larimer St., will be the other branch, extending from Eighth and Larimer to West Colfax Ave. and Larimer St., the former branch being 2300 ft. long and the latter 638 ft. Thus the total length of viaduct and approaches will be 8480 ft. The South Platte River will be crossed by a steel span, and there will also be steel spans over adjacent railway tracks. The larger part of the structure, however, is to be of reinforced concrete. The total cost will be nearly $800,000, exclusive of right-of-way, which, according to proceedings already carried through, costs about $94,000. The viaduct is to be built jointly by the city and county of Denver, the street railway system, and several railway companies, under an agreement made in April, 1913. The bond issue to cover the City's share of the cost (30%) was passed a month later, and the bonds have been sold.

A Locomotive Crane on Construction Work is being successfully used by the Duquesne Contracting Co., of Pittsburgh, in some new line work for the Lake Erie & Eastern R.R. at Youngstown, Ohio. The accompanying view shows the crane on temporary tracks alongside a concrete elevated structure. The concrete was mixed at a central plant and hauled in drop bottom buckets on flat cars to the crane which deposited it in the forms. The crane was also found very useful in handling forms, especially for the walls above the springing line of the arches, as shown in the view.



A Locomotive Crane as a Contractor's Tool

A Complete Cost-Keeping System, which is easy to keep and easy to use, is always an interesting subject to progressive contractors. On p. 365, of "Engineering News," Mar. 12, "A Practical Cost-keeping System for Contractors" was outlined by Everett N. Bryan, engineer for T. K. Beard, of Modesto, Calif. Its fundamental principle is to segregate the costs of the elementary operations of a contract so that they may later be combined as desired in estimating on other jobs involving some of these operations. Floyd L. Burr, of Vulcan, Mich., suggests that an informal statement of the matters which affected the progress and economy of a certain contract would be of considerable value in future estimating based on that particular contract, and well worth the slight additional labor involved. This is a good suggestion. Certain conditions well known at the time, but forgotten in the press of new work, often affect to a considerable extent the cost of certain operations. The kind of weather, quality of labor, labor disturbances, hardness of rock, accidents, machinery which "just fills the bill," or which "belongs to the scrap heap," are all items which qualify costs. A statement of such conditions accompanying the final cost record of the work, as outlined in Mr. Bryan's article, would prove a paying addition to this system.

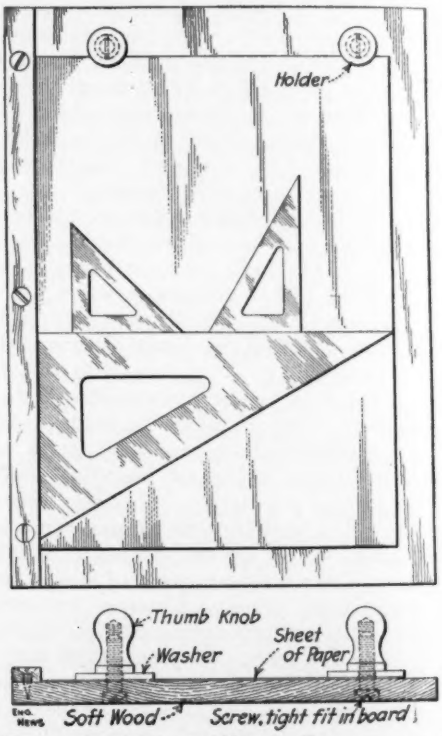
Regulations for the Protection of Street Trees in Philadelphia, have been approved by the Select and Common Councils and duly published. They were printed in the Mar. 28 "Bulletin" of the Engineers Club of Philadelphia and are as follows:

1. No tree shall be pruned, sprayed, planted in, cut down or removed from any highway in the City of Philadelphia without authority from the Commissioners of Fairmount Park.
2. No person shall climb upon, cut, break, bark, or otherwise injure or disturb any tree, treeguard or support thereof on any highway in the City without authority from said Commissioners.
3. No person shall fasten any horse or other animal to any tree, tree-guard or support thereof, or leave any animal fastened within reach of any tree, tree-guard or support thereof on any highway in the City.
4. No person shall attach any guy-rope, cable, wire or other fixture to any tree, tree-guard or support thereof on any highway in the City.
5. No person shall fasten or maintain any placard, sign, advertisement or other notice on any tree, tree-guard or support thereof on any highway in the City.
6. No person shall deface, injure or remove any copy of the Regulations for the Protection of Street Trees or other notice posted on any highway or other public place in the City by authority of the Commissioners of Fairmount Park.
7. No pavement of any kind shall be laid within a space of 3x4 ft. around any street tree, and no stone, gravel, cement, lumber or other material shall be deposited upon such unpaved area. Such unpaved space must be maintained permanently and continuously about the base of the trunk of each street tree.
8. Every person or corporation violating any of the foregoing regulations shall pay a fine or penalty of $5 for each and every offense.

The New 15-Cu.Yd. Dipper Dredge "Gamboa" arrived at **Colon, Panama,** Mar. 15, after a voyage of 26 days from New New York harbor. For safety in handling at sea the heavier parts of the machinery were knocked down and with the boom and two dippers were shipped separately by steamship. The hull of the dredge was towed by a tug and some very rough weather was encountered without accident. The second dredge of the same type, the "Paraiso," is expected to be completed about the middle of April. These dredges were described in detail in "Engineering News," of Mar. 12, and are built by the Bucyrus Co., South Milwaukee, Wis.

Small Sketch-Board for Loose Form-Sheets—A paper-clamp of a kind already illustrated in "Engineering News" is one feature of a sketch-board particularly intended for loose form sheets, designed by Chas. P. Wiweke, Albany, N. Y. The board and the paper-holding details are shown in the drawing herewith. The following describes it in the words of the designer:

The board is a piece of soft wood about ⅜ in. thick. The narrow strip to the left is hardwood, with edge planed smooth and true for the triangle to slide against. This eliminates the need for a T-square. The strip is held with three small screws. The paper-holding device consists of a thumb nut, a washer, and a button-head screw. The thumb nut when given half a turn will grip the paper so tightly that the paper would be torn before it would come out. Several sheets may be on the board at a time if desired.



Small Switchboard with Paper Clamps and Guide for Triangles

While the sketch-board is convenient for any small drawing work, one important use for it is in making sketches and the like on loose form-sheets. Defacing such sheets with thumb-tack holes is objectionable, but when not held in some way they are very hard to work on. With a board to the design shown here the difficulties are gotten around.

The American Society of Engineer Draftsmen and the Technical League of America have been consolidated as the Technical League of America. The officers of the consolidated Society are: President, Chas. Wm. Weick; Secretary, Walter M. Smyth. The headquarters are at 74 Cortlandt St., New York City.

Editorials

Manufacturers as Consulting Engineers

The complaint that manufacturing concerns are doing engineering work on plant design and construction in order to facilitate the sale of their product is not a new one. The specific form of this complaint, voiced by George Gibbs at the last meeting of the New York Railroad Club and noted elsewhere in this issue, shows that the difficulty is particularly acute in the electric-railway field. That the results are not always of the best is indicated by occasional reports which we receive concerning such work. If such practice does not tend to promote good engineering, every attempt to eliminate it is laudable.

Whatever may have been the situation once, there is now little attempt to eliminate the engineer in connection with the sale of ordinary machinery. Probably the situation still exists in the electrical field because of some continued need of stimulating sales. A similar situation seems to exist through competition in the smaller fields of heating and ventilating.

We must believe that this is a passing condition. The efforts of Mr. Gibbs and others to hasten its departure are in the line of obvious industrial drift, for such work in engineering design is out of harmony with the present tendency toward specialization in manufacture. At present, specialization in electrical manufacture is not as complete as in some other lines of industry; but, if the signs are read aright, it is inevitable. Specialization is a logical continuation of the division of labor which has developed during the past few centuries and has led to remarkable industrial developments.

The manufacturing concern is organized to carry on the special work of production. Its organization is not adapted to carry on the work done by the independent consulting and designing engineer. Its experts may indeed know more about electric locomotives than any consulting engineer; and more concerning the intricacies of motors, of insulators, and of the various details which involve whole arts in themselves. But the purchaser needs the advice of the engineer who can view the problem from a broader standpoint than any specialist, one who fully understands first of all the user's special requirements and who is not limited in his choice to the products of any single manufacturer.

Concerning "Calamity Reservoirs"

It is a difficult thing for an engineer to produce, at the present day, anything radically new in dam construction. So far as we are aware, however, the type of dam proposed by John W. Alvord for flood protection on the Scioto River, above Columbus, Ohio, is entirely new.

As described by Mr. Alvord in his paper published on p. 751 of our last issue, the distinguishing feature of the proposed dams would be the provision of permanent openings through the dam at its base. These openings would be designed large enough to pass not merely the ordinary flow of the river but a considerable flood before the reservoir would fill to the top. The volume of water passing through these openings will, of course, depend upon the head. Thus, at lowest water, in seasons of drought for example, the entire flow of the river would pass through the opening only partially filling it. At the average flow of the year, the reservoir might be filled so that there would be a head of several feet over the opening and the water would escape under pressure. In case of sudden flood, the reservoir would gradually fill, but the head of the water on the opening would increase as it filled so that more and more water would be discharged, until with the reservoir full the openings beneath the dam would be discharging as much water into the stream as would produce as large a flood as the stream channel would carry without serious damage. This, in brief, as we understand it, is the theory of the operation of Mr. Alvord's proposed type of "detaining dam."

We see no defect in the theory. In the practical execution of such a design, however, very great care would be requisite in order that trouble did not arise. For one thing, the power and velocity of a flood discharging through channels under a dam with the high head that would exist at flood time are something enormous. The erosive force of such a current is a thing to be taken carefully into account. Unless the dam were of very low height, no masonry could be relied upon to withstand such a current and the escape pipes would have to be built of heavy steel plate. Care would have to be taken that this huge jet did not have vibrations set up in it by obstructions or other causes. The dynamic effect of such vibration upon the dam structure might be serious.

Again, when great floods come, such as these proposed "Calamity Reservoirs," as Mr. Alvord terms them, are intended to absorb, a vast amount of wreckage is carried downstream. Much of this floats on the surface, but a great deal of it is carried along the bottom by the force of the current. There would seem to be a chance at least that sunken logs, boulders and similar materials might be swept down to the dam and carried into the waste pipes beneath it, causing them to clog, and perhaps setting up vibrations in the issuing stream of water as above suggested. It might be possible, by auxiliary dams or other means, to catch the débris brought down by the flood and protect the openings beneath the main dam from clogging; but plans for this would need to be carefully considered.

The principal advantage of this proposed type of dam is that most of the land in the reservoir back of the dam would never be overflowed save in seasons of exceptional floods, perhaps not once in a dozen or twenty years. For farming purposes, therefore, its value would be hardly affected. In fact, there are hundreds of thousands of acres of rich river bottom lands which are overflowed to a

greater or less extent almost every year, but which are accounted the most valuable portion of the farms of which they form a part. Since the value of the land necessary for reservoirs where stream regulation by storage is undertaken is one of the largest items of cost, Mr. Alvord's suggestion is an important one.

On the other hand, such a dam and reservoir serves no other purpose than protection against the destruction of a flood which may occur only once in ten or twenty or fifty years. It has generally been considered one of the most important advantages of the reservoir system of river regulation that it would increase the low-water flow of the stream as well as reduce the flood stages. The economic gain from supplementing the stream flow in times of drought is probably fully as great as from storing the floods. In fact, for either irrigation or city water-supply, the purpose of dam and reservoir construction is to maintain the flow at low water. Flood protection is merely incidental.

It has been objected that water storage to maintain low-water flow and water storage of floods conflict with each other, since for the former purpose the reservoir should be kept full and for the latter purpose it should be kept empty. It is, however, possible by intelligent use of the gates, to use a reservoir for both purposes, especially if the reservoir is designed with such ample provision for drawing off the water as Mr. Alvord proposes. Which plan is the better to adopt in a particular case will have to be determined by the engineer with regard to the local conditions.

What Is the Cheapest Type of Excavating Tool?

It is generally understood by engineers that the cheapest of all methods of excavation is hydraulic dredging. It is not at all uncommon for large contracts for hydraulic dredging to be executed under favorable conditions at a cost as low as five or six cents per cubic yard of material moved. Next to the hydraulic dredge as a machine for economical digging comes the ladder dredge with its endless chain of buckets. That typically American type of excavating machine, the dipper dredge, and its dry-land prototype, the steam shovel, are generally rated as more expensive machines for handling the class of materials where the hydraulic dredge or the ladder excavator works to best advantage.

It is of great interest, therefore, to note that under certain special conditions where the work is confined to digging alone, and the item of transportation does not enter, that typically American machine, the steam shovel, has shown its ability to handle material at a lower cost per cubic yard than has ever been attained, as far as we can recall, by any other type of excavating machine. On p. 722 of our last week's issue, we described the very large steam shovels which have been recently built for the work of stripping the overlying material from some flat coal seams in the Central West. These huge machines are actually steam shovels so far as all their operating machinery is concerned. They are similar to the well known railway type of steam shovel, but the complete machine is, of course, far too large to travel over a railway line. The buckets of these big machines have a capacity of 8 cu.yd., and swing from the end of an 80-ft. boom.

Under the conditions in which it is used for coal-seam stripping, there is no transportation whatever involved in handling the material, and the shovel works at its maximum efficiency since there is no time lost in waiting for trains, spotting cars, etc. The machine simply travels back and forth in parallel lines over the coal seam, excavating the entire mass of overlying material and dumping it to one side along the track made at the previous passage (the coal then uncovered having previously been removed).

Cost sheets of the operation of these machines have been shown us, indicating a cost including all operating expenses of between two and three cents per cubic yard. We believe this figure does not include the interest and depreciation on the shovel itself and other plant used, and we are uncertain whether it includes overhead charges. Making allowance for these things, however, it still remains such a remarkable showing for this typically American excavating machine that it deserves wide publicity.

From the point of view of the mechanical designer, it may fairly be said that the steam shovel with its various motions represents a greater feat of mechanical design than the ladder excavator, which is the typical digging machine of Europe. The steam shovel is, in fact, an attempt to reproduce by mechanical means the operation of the workman using a hand shovel. The astonishing reduction in cost of operation which results from developing the machine to extraordinary size is another notable illustration of the economic results which are possible nowadays when work is done on a sufficiently large scale.

Concerning Contractors' Bonding Companies

In the investigations into the contract work on New York State highways, which has been proceeding during the past few months, one feature which has been prominently brought out is the powerful influence exerted by some of the companies issuing contractors' bonds and their agents in connection with the award of the contracts and the relations of the State authorities to the contractors. There has been strong evidence of an intimate connection between some of the men "higher up" in the political machine and possibly in the State government itself and the companies which secured the lion's share of business from the contractors on the State work. There is good reason to believe that competition between the different companies issuing contractors' bonds is on the basis of securing inside influence in connection with public works of magnitude rather than competition conducted in the ordinary manner.

There is, on the part of contractors, a very general protest, we believe, against the charges and methods of the bonding companies. A formal expression of this protest was recently made by Mr. Lincoln Bush in the form of a letter which was read at the annual meeting of the American Institute of Consulting Engineers. As this letter is of wide interest to engineers and contractors, it has been given out for publication and we print it as follows:

As you are aware, it is common practice on construction work to require the contractor to provide a surety bond with a bonding company for faithful execution of the work. This is true of contracts for public works, such as city, county and

state work and is quite generally true of work let by private contractors where the importance of the work seems to make desirable such bond. Quite frequently, however, such bonds are not required by railroad and other similar companies.

I have noticed that there is no regular uniformity in the amount of the bonds specified by engineers, even though the hazard and character of the work is similar. To illustrate: I have seen in forms of contract, bonds specified varying from 25% to 50% on the same class of work. It has come to my notice that some engineers in making up their specifications and form of agreement, do not know that, without any regard to what they specify as to amount of bond, the bonding companies will not provide a bond except for the total amount of the contract. The present rate is ½% per annum on the total amount of the contract determined at the time of letting.

It will be evident to you from this that the ideas of the engineer who prepared the form of agreement are absolutely ignored so far as amount of security deemed necessary in the engineer's judgment, and, furthermore, since the bonding companies have united in requiring the contractor to take out a bond on the total amount of the contract, the engineer's client must necessarily pay more than his engineer advisor deems necessary, and this amount simply goes into the pockets of the bonding companies. There is neither equity nor justice in the attitude of the bonding companies regarding this matter; and it has seemed to me that a matter of this kind, disregarding the engineer's requirements and increasing the cost of work to his clients, is one well within the province of the American Institute of Consulting Engineers to consider. I would like very much if some action on the part of the Institute should lead to the breaking up of the combination of the surety bonding companies which now exists.

In two instances which have recently come under my attention and direction, the contractors have made an agreement with the owner which, though somewhat burdensome and unusual, has prevented the contractors referred to from being held up by the surety companies. In one case the contractor agreed to let the owner retain 20% of his estimates instead of 10% up to a time when the 20% reservation would reach a sum equal to $50,000, after which time the ordinary 10% reservation was made. In the other case the contractor had high-grade securities and deposited these securities with the owner, the same to be held as a guarantee for the faithful performance of the contract.

There is neither equity nor justice shown to the owner nor the contractor in the attitude of the bonding companies, and these bonding companies absolutely ignore and disregard the requirements placed in the contract by the engineer.

You can see how through political influence in large public works certain bonding companies might get practically all of the surety business. Take a contract, for instance, amounting to $3,000,000; the bonding company would require the contractor to pay ½% per annum on $3,000,000 for such bond; in other words, the contractor would pay $15,000 a year to the bonding company, and if such a contract covered a period of three years, as would likely be required with a contract of such magnitude, it would amount to an expenditure of $45,000.

Is it right that the owner or the municipality should be required to pay an amount governed by possibly selfish motives rather than the good judgment of the engineer, who should be fully qualified to appraise the hazards connected with the work?

I also know where a surety bond of this kind is taken out and where the engineer makes changes affecting the cost, etc., of the work, which frequently and necessarily occurs, that the bonding company regards any such change as a breach of contract with them so far as the bond is concerned and all such changes must be submitted to them for approval. You can readily see that in the event of the contractor failing how the bonding company might escape liability on the ground that it had not approved of such changes; and I have known cases of this kind to occur.

We understand that Mr. Bush's letter has been referred to a committee of the Institute for consideration. The subject is one whose importance will be generally recognized; but it will take a long and united effort to loosen the hold which the bonding companies have obtained in connection with contracts for public works.

It is not so very long ago, as the older generation at least of engineers and contractors will recall, when the bond required of a contractor was given in the shape of personal sureties. The difficulties in collecting from such bondsmen in case of default made it a very easy matter for the bonding companies to secure the amendment of laws, first permitting and then requiring the guarantee of public contracts by a bonding company. If the bonding companies' connection with politics were severed, it would be a comparatively easy matter for a number of large contractors to combine in the organization of a rival bonding company to conduct a competitive business. To do so at the present time, however, would be to incur the enmity of men of large political and business influence who are interested in the present bonding companies which have the power practically to say whether or not a contractor may do business.

In the conduct of private work, however, the way out for the defeat of the bonding companies is comparatively easy. When the owner for whom the work is being done is enough of a business man to realize that the fee which the bonding company exacts is in the long run paid by him and not by the contractor, it will be in many cases, comparatively easy to effect a mutual agreement between the owner and the contractor by which the services of the bonding company may be dispensed with.

The Confirmation of Prof. Winthrop M. Daniels as a Member of the Interstate Commerce Commission

In reports about the discussion preceding the Senate confirmation of the President's nomination of Prof. Winthrop M. Daniels as member of the Interstate Commerce Commission, stress seems to be laid on some opposition that developed, based on charges of pro-corporation prejudice. It is especially important in view of the valuation of railway properties now thrown upon the Interstate Commerce Commission, that capable and fair-minded men be selected for vacancies on this important board. If the Commission should be dominated by men of marked anti-corporation leanings, the railroads might suffer hardship; if the Commissioners should be deemed too friendly to any corporate interest, then their work might be discredited before the public. The most desirable men, of course, should be free from prejudice toward either side and it is pertinent, after these rumors, to examine Prof. Daniel's record.

There has been mentioned, specifically, as evidence of his alleged bias, the proceedings of the New Jersey Board of Public Utility Commissioners (of which he was a member) in its investigation of the rates of the Public Service Gas Co. Assuming, for the sake of the argument, that the New Jersey Board was very largely influenced by Prof. Daniel's views in this case, it is of interest to examine the report to find indications of bias, either for or against utility corporations.

This company was charging $1.10 per thousand cubic feet of gas, with a discount of 10c. for prompt payment. The Board, on account of complaints, initiated an investigation of the reasonableness of these charges. At the outset, the gas company, and the allied electric company, submitted a proposition gradually to reduce their rates. The Board refused to consider this, because it tied together two services having no relation with each other and fixed the rates for five years without investigation. The appraisal proceeded. The Commission found a value of tangible property of $3,725,000, while the company claimed $5,818,940. The Board allowed $1,025,000 for

all intangible elements under the name of "going value," against the company's claim of $3,090,000. The Board further found that a rate of 90c. per thousand cubic feet would return approximately 8% on the total appraised value. The company contended that the valuation fixed by the Board should not fall below the par value of securities originating in the merger (in 1899) of six different gas and electric concerns. In effecting the consolidation some $9,100,000 stocks and bonds were issued. The Board found that this capitalization was in excess of the real assets and that they were not bound by common law or statute to accept this figure, even though it had passed unchallenged by the State at the time of consolidation.

The company indicated its intention of contesting the basis of the Commission's valuation. Thereupon, the Commission openly expressed its hearty desire for a judicial review of the principles and accepted, without prejudice to the company pending settlement, its extension of the 90c. rate to the entire service of the company. The New Jersey Supreme Court has supported the Commission and the matter is now before the highest state tribunal, the Court of Errors and Appeals.

A careful reading of the report and order in this case will furnish cold comfort to anyone who believes in either extremely liberal or very harsh treatment of corporations. The Board very evidently aims to be fair and judicial. As an example of this judicial attitude, a few sentences may be quoted from the section dealing with "going values."

> We are of opinion that Messrs. Humphrey and Miller's estimate of the cost of reproducing the business cannot be accepted as controlling. * * * First, their estimate is based upon an excessive valuation of portions of physical property, notably land; * * * second, the two periods embraced in their estimate ought to have been partially telescoped; * * * third, the method itself is necessarily so hypothetical that it cannot readily be tested by the touchstone of reality. * * *
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> We find it also impossible to accept the minimum estimate of Professor Bemis of $171,000 as the possible allowance for preliminary and development expenses. * * * Professor Bemis has built his estimate upon the assumption that any preliminary development expenses or early overhead charges would surely be confined to the first million dollars invested in development and to sales of the first two billion feet of gas. * * *
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> There is no specific evidence that any of the franchises has a specific value stated in dollars and cents. * * * It is well known that it is the public policy of the State of New Jersey at present not to allow capitalization of franchises for an amount in excess of the actual cost involved in obtaining said franchises. That this is a wise and equitable policy we think is incontestible. * * * When by secondary franchises permits to locate are granted to a company without other expense than the necessary business and legal costs of securing municipal consent, it seems unthinkable, as a matter of equity and public policy, that the easements thus gratuitously granted should be made the basis for an additional charge to be imposed upon the grantor. * * *
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> There are virtually two contentions raised by the company to establish the aggregate value of these franchises. The first is based upon the capitalization agreed upon in 1899, when six different concerns merged and consolidated. * * * Whatever the precise amount of water that was injected in securities resulting from this consolidation, the company claims that these securities have been issued under due form of law, that they have been scattered far and wide, and people have paid for them with honest money. * * *
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> The contention that the aggregate face value of the securities originating in the merger cannot be questioned in a rate-making valuation we believe is wholly unfounded. * * * If the value of the company's property originally equaled the face value of securities, and if the present fair value of the property used or useful in serving the public has grown to exceed the power of these securities or has diminished so as to fall short of the face value, it is the fair value of the property, not the face value of stocks and bonds, that must control. If the value of the company's property never did equal the face value of the security, the case is, if anything, stronger for looking to the value of the property, and not to the nominal value of the securities, to find a base for fixing rates.

These and similar parts indicate proper solicitude for the public welfare. There should be an equal number of places where the report would show that the legitimate investor need not be discouraged. There are such passages and it is on them that the charge of bias presumably was made. Neither class of statement should be taken alone; taken together there can be no serious objections to either. On any grounds so far cited, there seems no good reason why Prof. Daniels should not prove an able and conscientious commissioner.

Letters to the Editor

Gases from Imhoff Sewage Tanks

Sir—In ENGINEERING NEWS, of Apr. 2, p. 760, you gave an analysis of the gases escaping from some of the Imhoff tanks in Atlanta, Ga. Comparing these results with those of septic tanks still so commonly used, and other sewage plants, they are exceedingly gratifying. The chief offensive gas, namely, hydrogen sulphide, which is responsible for practically all the stench connected with sewage, is found to be 0.0%; that is, it was completely eliminated in every sample that was taken.

This result, substantially, is expected in all Imhoff tanks that are properly designed and operated. And with this evidence coming from the largest Imhoff plant in our country, it is thoroughly gratifying at this day to maintain that it has at last become practicable and economical to dispose of the sewage of large cities without any disagreeable odors whatsoever, the last serious difficulty in the way of this desirable result having now been removed.

Attention should further be directed to the fact that 92.7% of the gases escaping are methane and hydrogen, and only 4.6% is carbon dioxide. This further result, when compared with the average German results, respectively, of 75% and 25%, also indicates that the much more dilute American domestic sewage when compared with European sewage, will offer no difficulties, either in extinguishing the activity of bacteria producing malodorous gases, or in maintaining the activity of those producing non-odorous gases.

RUDOLPH HERING.

New York City, Apr. 3, 1914.

Keokuk and Cupid

Sir—The inclosed clipping is from "Collier's Weekly." I have been a subscriber to ENGINEERING NEWS for 15 years and have read many articles in it relating to failures, damages and benefits of dam construction, but I have never seen any discussion in your columns about the feature of dam construction which "Collier's" refers to, and the engineering that it involved.

T. M. A.

Oswego, N. Y., Apr. 1.

[Notwithstanding the date of our correspondent's letter, it is no joke but a serious matter, as will be evident to any reader from the clipping sent, which we reprint as follows:

In Keokuk, Ia., an enterprising firm of capitalists built a dam across the Mississippi River and set the peerless Daddy of American waters to work running the trolleys, lighting the streets, and turning the washing machines in a hundred cities and towns. It was a tremendous job of work which involved the wiping out of farms and villages and railroads, the rearrangement of a hundred square miles of scenery, and some minor changes in climate; and, as usual with gigantic enterprises, it produced some unexpected results.

For one thing it brought great numbers of young engineers to Keokuk. They had worked all over the world on water powers, usually in spots well concealed from civilization and well insulated from feminine charm. Then they came to the Keokuk job, where, 15 minutes from the roaring rapids were the homes of Iowa's finest families, full of young women ready and willing to admire the wild, free life of the engineer. The result was over a hundred weddings in two years, and when the dam was completed and the young engineers moved on, they took with them the young women of Keokuk en masse.

In the interest of scientific accuracy we have investigated the above story and are informed that the exact number of weddings celebrated in Keokuk traceable to the dam is 68, up to the present time. Evidently engineers are proficient enough in this branch of engineering work to need no instruction from technical journals. We sincerely trust that in this important aspect of dam construction there may be no failures and no suits for damages.—ED.]

Useful Tests on Models

Sir—On the subject of the use of models in engineering design, previously discussed, I should like to submit the following.

While it is true that an ordinary tin bucket would be a poor model for a large-sized container of water, with its curved bail and thin, unstiffened metal, there are cases where models are eminently useful and tell a true story as to what may be expected in full-sized members.

Small compression members are, in a sense, models of large ones, and the information determined therefrom, in spite of the fact that it is often discredited, has proven to be reliable.

In some model tests described in Bulletin No. 44, University of Illinois Engineering Experiment Station, the web-plate of one of the compression members had a width between rivets equal to 50 times its thickness. Good specifications would limit this distance to 32 or at most 40 times the thickness, which means that model tests long ago discovered that this was a good limit. This particular member showed poor results, the web buckled and the lattice-bar stresses were high. The same member had lattice-bars of length between end rivets 70 times the thickness of the bar. This is also contrary to good specifications and to information well understood at the time of making these tests, information gained from model tests.

Such investigations are useless. They tell nothing regarding the strength of compression members of proper design, for the members tested are themselves of improper design. For instance, in these tests the stresses in the lattice-bars were measured; but the results found are quite misleading, for the reason that the members are so flimsy that lattice-bar stresses are necessarily erratic.

The same bulletin tells of inability to detect any lattice-bar stress in bridge members in service, showing that in properly designed members the lattice-bar stresses are small.

Some time ago, I helped to make tests on two of the largest column models ever tested. The members were exceedingly stiff laterally, having longitudinal diaphragms and double stiff lattice. They began to show signs of distress at just about the elastic limit of the steel (nickel steel), and failed at a load not much greater, exactly as small models will do. The first visible sign of failure was in outstanding metal that was relatively thin, precisely what a little model would do. The greatest lesson of these very tests is the fact that they acted just as little models would do.

EDWARD GODFREY.

Monongahela Bank Bldg., Pittsburgh, Penn.,
Mar. 28, 1914.

Compensation of Engineers

Sir—The compensation curve given in ENGINEERING NEWS, Mar 19, by George M. Purver, based on data obtained from about 600 engineers almost exactly hits one compiled by the writer on data obtained from 4024 engineers. They each told the amount of money actually earned each year after going into engineering work, together with the highest and lowest salary obtained, and the amount of lost time. The amount of lost time (i.e., idle time between jobs) depended largely upon the year of graduation; those graduating in flush times seeming to lose little time during the first ten years of their professional work.

From the reports were excluded all men who were in business for themselves as contractors, manufacturers, etc. (after they became business men), the inquiry being confined strictly to the men who kept close to engineering work, either on salaries or in private practice. The lost time in average years seemed for the first five years out of school to be less than one-fifth the total. In the second five years, as also in the third, the lost time was a trifle more than one-fourth the total. Between the fifteenth and the twentieth year the lost time was fully one-third, unless the man was prepared to drop down to pretty low pay and accept a decidedly subordinate position; which, of course, fixes the fact that there is an age limit. After the age of 45 it is exceedingly difficult for the average engineer to secure employment, he being taken only when there seems to be no opportunity to secure a younger man.

In your issue of Mar. 26, letters from C. E. and H. M. C. take up the old trouble of relative pay of clerks, steam-shovel engineers and professional engineers. An employer of mine about twenty years ago gave me the following recipe for obtaining success in life: Opportunity, 50 parts; ability and practical training (the mixture

making a reagent called "gumption"), 35 parts; special scholastic training, 15 parts; total, 100 parts.

One cannot help but observe as this vexed question of engineering compensation is studied that the recipe is very nearly right. Steam-shovel men can be trained only on steam-shovel jobs and men are needed who have good brains as well as plenty of brawn. This limits the supply and supply has much to do with compensation. There are clerks and clerks; the clerk most of us think of being the cheap bookkeeper and counter hopper, not stopping to think of the men responsible for keeping track of the multitudinous and multifarious details of a business. They are termed clerks because their work is clerical but it is of a very high order. There is always a demand for such men and their employment is not so sporadic as that of engineers, yet they find that as the years go by they fall into an age-limit class once they lose a position. They are paid for the work they do just as engineers are paid—in direct proportion to the responsibility and inversely with the ease with which they may be procured.

Any boy with a fair brain who is able to complete a high-school course may complete a course of study in an engineering school. There are more than 200 such schools in the United States and at present engineering education is the fashion. If the students would look upon it as merely the modern idea of education as opposed to the old classical courses and go into the world to do what they can, all would be well. Unfortunately, the majority try to practice engineering. The result is overcrowding, which brings low pay. This emphasizes the large part played by opportunity. The school training alone does not entitle the man to high pay; plenty of practical experience added to it does entitle him to high pay.

The only way conditions may be improved is to establish some form of employment bureau of a workable nature in the large engineering societies so the lost-time item will be reduced. It is the necessity for employment and the haphazard way engineers have for securing it that brings down pay. There should be some way in which an engineer who will shortly be out of work may be provided with a new job so there will be a minimum of lost time and therefore no going into debt between periods of employment. So long, however, as men think they should get good pay merely because they have received school training, there will be heart breakings and disappointment for many.

ERNEST MCCULLOUGH.
1302 Monadnock Block, Chicago, Ill.,
Mar. 30, 1914.

The Testing of Sand for Concrete

Sir—In the article published in ENGINEERING NEWS, Feb. 5, and Mar. 12, 1914, entitled, "The Testing of Sand for Use in Concrete," by Cloyd M. Chapman, there are some laboratory methods which are open to criticism. While it is true that many of the tests made are of doubtful value, some of those tests which should be valuable are made doubtful by crude methods.

Per Cent. of Voids—Mr. Chapman determines the percentage of voids by attempting to fill them with water, in his first and second methods. These methods, while probably near enough for a field determination where laboratory equipment is not available, are inaccurate. A much better method is to compute the percentage of voids from the specific gravity

$$\frac{sp.gr. \times 62.4 - wt.}{sp.gr. \times 62.4} = voids\ in\ per\ cent.\ of\ total\ volume$$

Mr. Chapman attempts to do this in his third method but assumes the specific gravity to be 2.65, whereas it may be anything from 2.60 to 3.00. It is hard to understand why anything should be assumed in a laboratory with apparatus at hand to make a definite determination. In comparing this method with the water method with a a sand weighing 93 lb. per cu.ft. and having a specific gravity of 2.66, it was found that the percentage of voids was 44, while by the water method three determinations gave a percentage of 35, 36 and 36.

The method followed in filling the container does not make any material difference provided the sand is dry and is not rammed or shaken.

Specific Gravity—What Mr. Chapman terms specific gravity of sand is not specific gravity, as he says, and should not be called such. The use of a 200 c.c. graduate with 100 c.c. of water and 100 c.c. of sand is inaccurate, owing to the small quantities used and the impracticability of making a close reading with this type of graduate. An error of 1 c.c. in the reading will cause an error of 0.05 in the specific gravity. In a laboratory where cement tests are made there should be an apparatus for determining the specific gravity of cement such as the Jackson, which will give much more accurate results. An apparatus of this kind may be readily used for determining the specific gravity of sand.

Percentage of Silt—The matter of silt determination would seem to be disposed of in the mechanical analysis.

Percentage of Volatile Matter—A percentage of combustible matter determined on the fine material alone is inaccurate. When organic matter exists in sand to any extent, much of it is too large to pass a No. 100 sieve and a determination made on this material is no indication of what is contained in the sand as a whole.

Compressive Tests—This is, as Mr. Chapman says, the most valuable of all tests, and yet he attempts to draw conclusions from one specimen of each mix at each of the periods 7 and 28 days. No conclusive test of mortar or concrete can be made with one specimen; 2-in. cubes often vary as much as 500 lb. per sq.in. in compressive strength even when made from the identical mix by experienced operators. Not less than three and preferably more specimens for each proportion and each test period should be used in making a determination of the compressive strength. As it is on this test that a sand would be finally accepted or rejected, it seems strange that Mr. Chapman should give it so little attention.

Mr. Chapman errs in assuming that little is known of sand testing for use in concrete. Investigation has been carried on in this line for the past eight years in the laboratory of the Board of Water Supply of New York City, and during that time more than 1500 tests of sand have been made. The tests finally decided on as of sufficient value to spend any time on are Weight per Cubic Foot, Percentage of Voids, Mechanical Analysis, Specific Gravity and Compressive Mortar Tests. Tests for organic matter are made only when there is reason to believe that the sand contains a sufficient quantity to affect its use as an aggregate. Other tests are interesting but of little practical value.

In conclusion, it may be said that many engineers

still look on laboratory tests as of questionable value, and elaborate tests which give no adequate practical results will not help to dispel that idea.

CHARLES M. MONTGOMERY,
Inspector, Board of Water Supply, City of New York.
147 Varick St., New York City, Mar. 16, 1914.

[The above letter was submitted to Mr. Chapman, who has replied as follows.—ED.]

Sir—Mr. Montgomery's criticisms of the articles on sand testing are all very interesting, and some of them are proper. As there was no claim to perfection, criticism is welcomed, especially when constructive.

A few of the points raised would probably not have been brought forward if it had been made clearer in the articles just why certain of the methods were used in the particular forms described.

In any discussion of the papers it should be borne in mind, as stated in one of the opening paragraphs of Part I, that many of these tests are of doubtful value and are performed for the sole purpose of gathering data which may assist in developing ultimately a satisfactory series of tests for sand.

Several of the alternate methods employed are used largely for the reason that they have been and are in use by several other laboratories and their use is being continued in this laboratory in order to accumulate data whereupon they may be either established or discarded. These remarks apply particularly to the determination of voids and silt. The method of determining voids by filling a container with the sand and then adding water is the most commonly used laboratory method. Some laboratories assume a specific gravity of 2.65 and compute the voids after weighing a known volume of the sand. While both methods are open to criticism yet they are worthy of the investigation that is being given them.

The discrepancy between the two methods of determining voids which is illustrated by figures by Mr. Montgomery has been noted in this laboratory even to almost the identical figures, but even that does not settle once and for all which method shall be used exclusively by all testers of sand.

Mr. Montgomery's statement that "the method followed in filling the container does not make any material difference provided the sand is dry and is not rammed" has been found difficult to verify. A long series of tests conducted a year ago gave some surprising variations in results.

Mr. Montgomery indicates that he considers a possible error of 0.05 in determining specific gravity too great. If necessary, the specific gravity might be determined to the third decimal. There are those, however, who think that within even wider limits than 0.05, the specific gravity does not greatly affect the value of a sand for use in concrete. The questions to be settled are (a) How closely is it necessary to determine the specific gravity? and (b) What is the simplest method of making the determinations within the limits decided upon? If anybody can answer these two questions in a manner acceptable to all concerned, there would be at least one step in the testing of sand disposed of.

The method used for determining organic matter or volatile matter may be all wrong. It would be a grand thing for the concrete industry if we only knew how to determine what is the matter with certain sands, which, although their other physical characteristics appear quite acceptable, yet will not make good concrete.

In carrying out the method described, if organic matter is present in a sand in the form of roots, twigs, pieces of leaves and vegetation in various forms, these will rise to the surface when the sand is repeatedly shaken in an excess of water and the water decanted or siphoned off. Such vegetable matter, in addition to the extremely fine material adhering to the sand grains, is included in the result. Furthermore, there is probably greater accuracy in determining the volatile matter in a comparatively few grams of concentrates than in a larger amount of a material containing a very small percentage of volatile matter.

As to compressive tests, there is no exaggerating their importance as an aid in judging a sand and there is no danger in making too many of them, and it is common in this laboratory to run several series of these when occasion arises. What should be borne in mind in this connection, however, is the fact that with the results of a series of mixes tested at 7 and 28 days a curve may be drawn that at once shows up the regularities in the results on any of the specimens and that in reality every cube made is a check on every other cube, even though the proportions differ. This is vastly different from attempting to draw conclusions from one specimen as is charged, by implication, in the criticism.

If somebody knows at the present time just how sand for concrete should be tested, he would confer a great boon on the engineering profession and save a vast amount of investigative work which is now being carried on, if he would come forward and tell us the methods in detail. Or, if somebody can write a specification for fine aggregates which will include all suitable materials and exclude all unsuitable ones, this would be a very good time to spring it on the engineering profession. It would be useful.

What is urgently needed now is light on the subject, discussion and constructive criticism, methods and results; to the end that fixed standards may be adopted.

CLOYD M. CHAPMAN,
Engineer of Tests, Westinghouse Church Kerr & Co.
35 Wall St., New York City, Apr. 2, 1914.

NOTES AND QUERIES

We are requested to warn engineers against an impostor who has solicited loans from engineers in New York City, representing himself at one time to be Edward Schildhoner, Electrical and Mechanical Engineer on the Panama Canal work, and at another time to be a brother of Mr. Schildhoner. The man is about 40 years of age, weighs about 115 lb., has light complexion and hair and sharp features.

ERRATA—The Inland Steel Co. requests us to correct an error made by its advertising department in an advertisement published in our issue of Mar. 5, describing the use of Vismera iron in the construction of two docks and warehouses at Seattle. The advertisement stated that the Dunkin-Thompson Co. were the contractors who erected these buildings, while as a matter of fact they were the sales agents who sold the iron to the contractors who did the work.

Railway Earnings from Carriage of Mail for the Government were $300,000 less in 1912 than in 1907, while the Post Office revenues increased in that time $63,000,000. The Committee on Railway Mail Pay of the American Railway Association claims that at present the railways are underpaid at the rate of $29,000,000 per annum.

The Panama Lock-Gate Claim

Some details of the interesting claim made by the McClintic-Marshall Co., Pittsburgh, for extra work in the manufacture and erection of the Panama Canal lock gates were given before the Appropriations Committee of the U. S. Senate a short time ago. The nature of the claims is described in general terms in a letter from the company to Senator G. T. Oliver of Pennsylvania (who presented the claim), the largest part of which is quoted below:

We have completed our contract with the Government for the construction of the Panama lock gates.

This work has been finally accepted, and the contract has been executed to the satisfaction of the Isthmian Canal Commission, both as to workmanship and time of completion.

In order to complete this work, to meet the Government's requirements as to workmanship and time of completion, it has been necessary to expend $2,394,480 over and above what would have been necessary had the work been executed under fair conditions and inspection. This extra cost is made up as follows:

1.	Material rejected on account of unreasonable inspection	$60,000
2.	Extra shop cost due to unreasonable inspection and delay incident thereto, 51,300 tons, at $7.60 per ton	389,880
3.	Loss on reduced output, due to unreasonable inspection and delays incident thereto, 20,000 tons, at $9 a ton	180,000
4.	Extra field cost, due to unreasonable inspection and rush	1,644,600
5.	Extra cost cleaning steel for field painting	120,000
	Total	$2,394,480

We give below an explanation of these items:

Item 1—Covers the cost of material rejected, on which more or less shop work was done and had to be replaced, due to the unusual and unreasonable inspection, both as regards material and workmanship.

Item 2—When we started the shop work on this contract the Government had little or no organization to look after the shop inspection. A large part of the first eight leaves was manufactured according to our interpretations of the specifications and with the same care and methods that we had been accustomed to use on other high-class structural steelwork.

After we assembled the first leaf at our shop, the work did not fit with the precision, as to details, demanded by the chief inspector. No work, up to this time, had either been accepted or rejected, but on going over the assembled leaf, the inspector practically condemned all work up to that time. After a long and serious delay we were made to realize that the inspector would and did require that the remaining work be done with the precision and accuracy of a machine-shop job, instead of a structural job. This necessitated an entire readjustment of our shop methods, increasing our cost, reducing our output, and delaying the work generally.

The condemned work on the original eight leaves was finally accepted under protest. The material was sent to the Isthmus, erected, and completed. The results were far better than the Commission ever hoped to secure under the specifications, thus sustaining our contention that we knew what kind of work was necessary to obtain the desired results.

Under these circumstances, it is only just that the Government should pay the extra cost of the shop work, as noted, which is the difference between what it actually cost and what it would have cost.

Item 3—The output of our shop during the time it was engaged on this work was reduced 20,000 tons, due to the unreasonable requirements and inspection of the Government, whereas it should have been increased owing to the large duplication of parts in these gates.

This loss in tonnage and the resultant money loss can be verified from our records.

Item 4—The extra field cost was due to the unreasonable field inspection and the fact that the work was delayed to such an extent at the shop by the Government that it became necessary, in order to meet the time of completion demanded by the Government, made for reasons best known to the commission, to send nearly three times the amount of equipment and number of men to the Isthmus to accomplish the desired results. At one time we had over 5000 men working on these gates, working day and night, in order to complete them by the dates required.

Item 5—The paint specified for the shop coat was wholly inadequate to protect the material until it was ready for field painting. This necessitated very heavy expense in cleaning and scraping the steelwork after it was erected.

The amount mentioned is practically the cost as shown by actual records.

Col. George Goethals was present as a witness before the committee and some of his testimony was as follows:

The contract provided for the completion of the gates on the 1st of June, 1913. It subsequently developed that the contractors would not be able to complete within that time, and the question of an extension was taken up, with a modification of the contract relative to the penalties that would be imposed for noncompletion. I then learned that it was the fault of the commission's inspectors that the time limit for delivery could not be complied with. How far that extended, or to what amount of additional expense the contractors were forced, I am not prepared to state. I do know, however, that the contractors, notwithstanding the fact that everybody on the Isthmus knew they must be losing money, spared no expense, spared no material, nor spared any man to exert their utmost to the completion of those gates.

I also know that the completed gates are far superior to anything that I had ever anticipated or have ever seen in the way of lock-gate construction. Ordinarily, in viewing the lock when the gates are closed, you will see water bubbling up around the miter sill and between the leaves, but they have been obliged to grind those bonding surfaces of the gates so closely that there is absolutely no leakage passing either around the sills or between the metal surfaces of the gates.

My sympathies have been with the contractors, and if I could help them out under the contract I would gladly do it.

Now, that is my position, and has been all along.

It has been the best carried on contract. There has never been any whimper about the inspection, and anything that we have asked them to do they have gone ahead and done.

[Question]—Is it claimed by these gentlemen that they bid upon the basis of structural steel something like what would go into these business blocks and were required to polish and grind and fit as if they were constructing a gun or some part of a ship? I take it that this is the claim.

[Col. Goethals]—That is the contention. They have never done any work of this character heretofore. They are bridge builders and structural steel men.

[Question]—When these bids were solicited by the commission, were the requirements of this extra work, if I may term it so, set out in the specifications?

[Col. Goethals]—I do not believe so, other than to state that the work should be done to our satisfaction.

Still further explanation was given by C. D. Marshall, President of the McClintic-Marshall Co., in the following statement to the committee:

When we prepared the estimates on this work, we felt that we were perfectly capable of knowing the kind of work that was required to do the job. We had executed some of the largest structural-steel jobs in the United States to the satisfaction of the purchasers and to our own credit.

We made a very careful estimate of the work, and in going over it today we see no reason why the estimate is not correct; but when the inspection was started, we soon realized that it was so severe, the requirements were so unusual, that we had no recourse excepting to go ahead and do the work exactly as they called for it, which necessitated a very large expenditure of money that was never contemplated.

Before we bid on it I went to the shipyards and examined all the ship work, and was satisfied we could do the work very much better than any ship that was ever built. When the first leaf was assembled, it had little inaccuracies that are customary in structural-steel work.

Then we had to remodel the whole plan of our shop, and we had to execute it purely as a machine-shop job. It is not a ship job; it is not a structural-steel job; it is a machine-shop job. The subsequent specifications for the rising-stem gate valves stated that that particular work was to be considered as a machine-shop job. After we got into this contract we realized that our first duty was to complete the work; our obligation was to finish that work without regard to cost or consequences to us. We went ahead and finished it without ever saying a word about how it was affecting us. We have finished the job, and we have made no request for any extras until the job was finished and accepted. Now we feel that we have been subject to a very severe expense

and all we ask the Government to do is to pay us for what additional work we have been required to put on that.

The work was delayed for months and months. We filed our claim for extension of time. No attention whatever was paid to the claim. We never went to Col. Goethals for anything until we could not get results through the regular channels, and when the time came that there was a penalty accruing and our payments were going to be stopped, then we went to Col. Goethals and presented our case to him. He examined it, and he said he had to have those gates at a certain time, regardless of whether we were entitled to extension of time or not. We accepted a supplementary agreement on the time of completion that he asked us to make. We went ahead, and we used every affort that was possible for human beings to use to get that done; and we did it.

[Question]—You used the term—I will say the almost harsh term—"unreasonable inspection."

[Mr. Marshall]—It was unreasonable as to the specifications. You know, a man may specify a certain condition to be obtained. Now, if we are to be the judges of how that result is to be obtained, then we go ahead and execute the work and are responsible for the results. But if the Government steps in and says that in order to obtain such results you must do it so and so, takes charge of our shops, and tells us how each particular thing must be handled, that is another matter. They demanded conditions that we never heard of before in structural-steel work. There is no shipyard that has ever handled a piece of work like this. When those leaves were assembled on the ground and ready for test, in a number of instances all the joints that leaked were finished up and closed and calked within a few hours or a few days; and there never was a ship built, I believe, but what it took weeks and weeks to calk the rivet heads.

[Question]—What was it that was rejected and was afterward accepted?

[Mr. Marshall]—One side of the leaves has a curve, and they are covered with plates. We punched the material by putting it through a machine, automatically spacing it. The holes in that plate have to match the girders. Now, when the plates were bent around these girders, the holes did not match exactly. They were not concentric. One hole was a little past the other, which is always the case in the kind of work we build. The specifications required them to be reamed out with a reamer before the rivet was driven, and, in every case within reason, that was reamed out, but maybe in one case we threw the reamer to one side a little more than the other side; but when the rivet was driven it was perfectly tight and water-tight. There was no criticism as to the dimensions or the shape of the structure as a whole. It was just as to the details.

The original contract for the lock gates was made June 21, 1910, on a unit-price basis whose principal item was for the riveted structural steel of the lock gates furnished and erected, 101,307,200 lb., at 3⅞c. per lb. The total of the contract according to the estimated quantities was $5,374,474.82. The time of completion was almost exactly three years, but it involved a schedule according to which particular gates were to be completed at set dates ranging from November, 1911, to June, 1913.

The time of completion proved to be impossible to maintain—on account of the extra delays caused by inspection, it is alleged. On May 20, 1913, that is to say, eleven days before the expiration of the original contract, a supplemental contract was made between the Isthmian Canal Commission and the McClintic-Marshall Construc- Co., extending completion at Gatun and Pedro Miguel to Jan. 1, 1914, and at Miraflores to Mar. 1, 1914. At the same time, however, the liquidated damages for each day's delay on each of the three groups of gates were changed from 0.1% to 0.125% of the contract price for that group. There were also countervailing concessions made by the contractor in connection with work on dock gates at Balboa.

The contract as thus modified was successfully carried through and the work has been finally accepted for some months past.

The request made to the Senate committee is that the amount of the claim be appropriated in the Urgent Deficiency Appropriation bill, as a maximum to cover any findings on the claim, and that an audit board be set to work investigating the items of the claim and fixing the amounts to be paid.

A Joint Committee of National Engineering Societies on Electrolysis of Underground Structures

At the instigation of R. D. Mershon, then President of the American Institute of Electrical Engineers, a movement was started to organize a joint committee representing all of the engineering societies of the country interested in electrolysis of underground structures, to which committee eventually would be referred for review all disputes over cause and remedies in any case. The first meeting was held in New York City, May 27, 1913, and the organization was laid out with B. J. Arnold, temporary chairman. At that time the Committee was constituted as follows: B. J. Arnold, of Chicago; F. N. Waterman, of New York; and Paul Winsor, of Boston, for the American Institute of Electrical Engineers; R. P. Stevens, of Allentown; Calvert Townley, of New York, and A. S. Richey, of Worcester, for the American Electric Railway Association; E. B. Katté, of New York; D. J. Brumley, of Chicago; and W. I. Trench, of Baltimore, for the American Railway Engineering Association; H. S. Warren and F. L. Rhodes, of New York, for the American Telephone & Telegraph Co.; Philip Torchio, of New York, L. L. Elden, of Boston, D. W. Roper, of Chicago, for the National Electric Light Association. At that time the useful work of the joint committee was held up pending the appointment of delegates from the American Gas Institute, the Natural Gas Association of America, and the American Water Works Association.

A subcommittee was appointed on scope, organization and plan of work, comprised of Calvert Townley, F. N. Waterman, E. B. Katté, and H. S. Warren.

At the second meeting of the Joint Committee, nearly a year later (Feb. 25, 1914), it was announced that A. F. Ganz, of Hoboken, J. A. Gould, of Boston, and J. D. von Maur, of St. Louis, would represent the American Gas Institute; while the Natural Gas Association had appointed, as its members, C. B. Olyphant, of Buffalo, W. J. Broder, of Columbus, and Forest Towle, of New York. This left only the American Water Works Association unrepresented. The meeting was largely confined to a statement from the Subcommittee on Scope and Plans.

The third meeting was held in New York City, Feb. 26, 1914. At this time it was announced that the U. S. Bureau of Standards would be represented by E. B. Rosa, of Washington. It was voted that Dr. Rosa be appointed Secretary of the Joint Committee and a member of the Plan and Scope Subcommittee. The chairman was authorized to appoint further subcommittees as had been formerly recommended by the Plan and Scope Subcommittee. The following were announced: Principles and Definitions, E. B. Rosa, Chairman; Methods and Analysis of Surveys, J. B. von Maur, Chairman; Foreign Practice, Philip Torchio, Chairman; Domestic Practice, F. N. Waterman, Chairman.

New Electric Towing Locomotives for the Panama Canal Locks*

The new design of towing locomotives for the Panama Canal locks is shown in the accompanying figure. This supplants the design previously adopted (described in ENGINEERING NEWS, Mar. 21, 1912), the trial unit of which proved unsatisfactory.

The locomotive is built up of cast-steel side and end frames, cross-ties and bedplates. It is mounted on two axles with wheels in accordance with M. C. B. standards. The entire frame is supported from journal boxes of railway type by coiled springs. The sides and top of the body are inclosed by sheet-iron covers which fit in place and are very easily removable.

The machine is propelled by means of a rack rail, while towing and while going up or down the steep grades from one level to another, at a speed of 2 miles per hour. While running idle or on return tracks, the speed is changed to 5 miles per hour with propulsion by ordinary traction, the rack pinion being entirely released. This change is affected by manually-operated clutches located in the gear mechanism in connection with a lever in each cab.

The locomotive is driven by two 75-hp. fully inclosed motors of mill type, one being geared to each axle. Three-phase 25-cycle 220-volt current is used, collected by contact plows. The motor and traction gearing is mounted on a common baseplate, which in turn is mounted on a driving axle and spring suspended from the locomotive frame much as in regular railway practice.

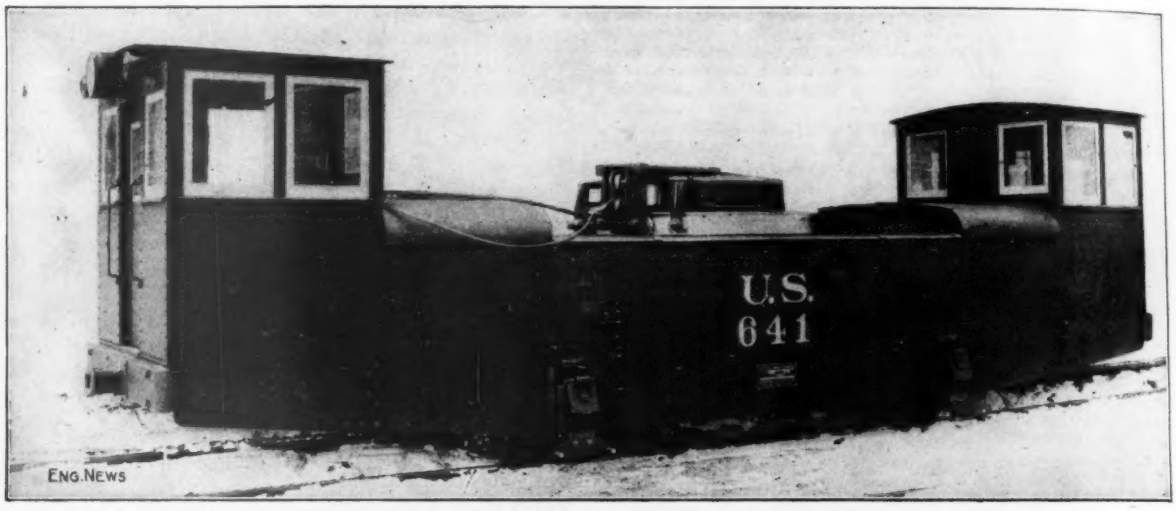
In the center of the locomotive is located a vertical-shaft windlass and drum, with capacity for 800 ft. of 1-in. steel cable. The windlass, with its driving motors and gearing, is mounted on a solid baseplate independent of the locomotive frame. The drum extends above the locomotive cover and carries a floating guard to retain the cable while coiling.

The windlass is worked by two 20-hp. motors of a fully inclosed mill type. One is geared for a rope speed of 12 ft. per min., at a pull up to 25,000 lb. on 3-ft. radius, and its function is to adjust the position of the towed ship for anchor or while going through the locks. The other motor is geared for a rope speed of 200 ft. per min. and its duty is to take up slack or pay out cable as may be required. The drum is driven through a friction coupling which can be set at any desired value from zero up to the full motor capacity.

All motors are controlled from either cab. The traction motors are operated by one master controller and contactors forward and reverse; the windlass motors are operated by a reversible drum controller and the clutch on the main vertical shaft is thrown by solenoid.

The leading dimensions are as follows:

Weight	82,500 lb.
Length	32 ft. 2½ in.
Width	8 ft.
Height over cabs	9 ft. 3 in.
Max. traction effort	47,500 lb.
Rope pull	25,000 lb.



NEW TYPE OF PANAMA CANAL TOWING LOCOMOTIVE

*From information furnished by the General Electric Co., Schenectady, N. Y., designers and manufacturers of the locomotive.

The Latest Water-Works Project at Ottawa, Ont.: Mechanical Filtration

[FROM A SPECIAL CONTRIBUTOR]

At a special election held last week the citizens of Ottawa voted by 10 to 1 to have an improved water-supply, and by vote of 7 to 6 expressed a preference for the Ottawa River purified by means of mechanical filters over a supply from Thirty-one Mile Lake. The Ottawa River project involves the construction of purification works on the main land, and with pipe lines and other structures complete is estimated to cost $1,700,000. The Thirty-one Mile Lake project is the one recommended by Sir Alexander Binnie and Dr. A. C. Houston, of London, England, involving an expenditure of $8,000,000.

This plebiscite is the latest development in a long and bitter controversy. In 1910 (ENG. NEWS, Nov. 10, 1910) Allen Hazen reported to the city recommending a water-supply from the McGregor Lakes in Quebec, at a cost of about $2,300,000. As an optional supply, Mr. Hazen proposed mechanical filtration of the Ottawa River. In

1911, following a serious outbreak of typhoid fever,* a pure-water commission was appointed, consisting of Allen Hazen, C. H. Keefer, Drs. J. W. S. McCullough and C. A. Hodgetts. The majority of this commission reported (ENG. NEWS, Dec. 7, 1911) in favor of McGregor Lake, Mr. Keefer submitting a minority report in favor of the Ottawa River. The McGregor Lake project was submitted to the people in 1911 and was defeated. The city council, following popular clamor, then ordered the city engineer to draw plans and specifications for slow sand filters for the Ottawa River, although Mr. Hazen had emphatically stated in his report that they were not suitable for this water. The Provincial Board of Health refused to approve these plans.

About this time, a second outbreak of typhoid fever occurred and the Provincial Board of Health ordered the city to install a mechanical filtration plant, following the general plan previously proposed by Mr. Hazen. In accordance with this order the city employed Messrs. Hazen & Whipple to draw the plans. This project was voted upon at the city election in January, 1913, and was defeated, due to a vigorous campaign against mechanical filtration, by one of the papers of Ottawa. The newly elected mayor, fulfilling a promise made before the election, secured Sir Alexander Binnie and Dr. A. C. Houston to report on the best means of securing a water-supply for Ottawa. Following a visit to Ottawa in February, these gentlemen submitted a tentative report recommending the securing of a supply taken from the northern lakes. Surveys were then made, and a final report submitted in August, 1913, recommending that water be taken from Thirty-one Mile Lake. This was noted at length in ENGINEERING NEWS, of Nov. 20, 1913. This report was approved by the city council, and Sir Alexander Binnie was instructed to draw the plans and specifications. [See editorial comment on the Binnie contract, in the issue of ENG. NEWS, just mentioned.—ED.]

Vigorous opposition to this report soon developed in Ottawa, one of the papers objecting to the scheme on account of the cost and other reasons. On a taxpayer's suit the bylaw authorizing this work was quashed by the supreme court of Ontario, on the ground that the special Act obtained from the Legislature authorized an expenditure of only $5,000,000, and that this act did not authorize the city to proceed with a project the estimated cost of which was $8,000,000.

Immediately upon the rendering of this decision, the Provincial Board of Health, of Ontario, ordered the city to proceed with the work. Another bylaw, passed by the city council under this order, was later quashed by the courts, which decided that the Board exceeded its authority under the Act.

The municipal election held early in 1913, resulted in the defeat of the mayor then in office, who ran on a platform that he would put through the Binnie or Thirty-one Mile Lake project without further vote of the people. Following this election, it was proposed to hold a plebiscite upon all of the projects which had been proposed. This plebiscite included three different projects for the Ottawa River, one for the Thirty-one Mile Lake, one for McGregor Lake, and one for no improvements in the water-works at all. The court refused to allow this plebiscite to be put to the people, on the grounds that "it appears to be an attempt to stifle the free expression of the opinion of the electors rather than to obtain it."

Although this decision made invalid the call for bids for the long gravity steel conduit proposed by Mr. Binnie, and, the local opposition press declared, enabled American bidders to submit straw bids, yet the bids were opened on Feb. 3. [See our Construction News Section, Feb. 12, 1914, p. 88, for list of bids received at that time.—ED.]

The next attempt to obtain the Thirty-one Mile Lake supply was by means of a special act of the Ontario legislature authorizing the expenditure of $8,000,000. This attempt was unsuccessful and resulted in a plebiscite, containing two projects, only, as suggested by the Provincial Legislature, being put to the people.

The project approved was one for mechanical filters, drawn by City Engineer Currie. It differed from the Hazen plan in that it is proposed to put the works on the mainland instead of on Lemieux Island. It is evident that this plan was adopted to meet the objection of those who were opposed to carrying the filtered water under the Ottawa River. This objection is due to the fact that the previous epidemics of typhoid fever have been caused by leaky intake pipes which were laid in the river and in a badly contaminated power canal leading to the pumping station. The Hazen plan proposed to carry the water from the works on the island to the pumping station through a tunnel under the river. The works were to be located high enough so that the pressure would always be greater inside the tunnel than in the river, thus avoiding all possibilities of inward leakage.

There can be but little question that mechanical filters will satisfactorily treat the water of the Ottawa River and afford a good supply of water for the city. The water from the Ottawa River is a soft, highly colored water, high in organic matter, but is not highly polluted, the population on the catchment area not exceeding 3 per square mile.

There is no evidence that the water from the Ottawa River itself has ever caused a serious epidemic of typhoid fever in the city. The epidemics which have occurred have come from pollution due to leaky intake pipes or the opening of emergency valves. The vote of the people seems to indicate that the large expenditure for the Binnie scheme did not seem to them justified when a satisfactory supply could be obtained at a lower cost.

Consulting Engineering by Manufacturing Concerns

Complaint has frequently been heard for a number of years past that manufacturing concerns were stepping outside their proper sphere as producers of engineering equipment and advising prospective purchasers as to the layout of works wherein such apparatus was to be used. The condition seems to have been most marked in the electrical field, and more particularly in electric-traction work, for here perhaps greater stimulus to purchase product has been necessary than in other industries.

The latest word heard on this subject was given by George Gibbs, Consulting Engineer, of the Pennsylvania R.R., at the recent (Mar. 20) "electrical night" of the

*See "Eng. News," Mar. 23, 1911, for article by Dr. P. H. Bryce on this outbreak, with maps showing water intakes and submerged conduits; also "Eng. News," June 1, 1911, p. 677, for note summarizing report on outbreak by Dr. C. A. Hodgetts, Sanitary Expert, Ontario Conservation Commission.—Ed.

New York Railroad Club. This part of his remarks is reprinted below.

I think the time has arrived when some one must publicly call attention to something which has been too long neglected. I wish, however, what I say to be taken as illustrative and not as unduly critical of the particular illustrations used.

It has been a favorite amusement at engineering meetings to draw out a lively electrical discussion by combating views known to be held by certain able and eloquent gentlemen. It also appears to be considered good business for large manufacturing companies to advocate in an uncompromising manner the adoption of this or that traction system. This, again, does not settle the system question upon a legitimate basis.

Two large electric manufacturing companies of this country are preëminent in the electric traction field and both manufacture excellent apparatus; because of agreements as to the common use of patents, there appears to be no reason why either company cannot offer any or all of the machinery required for any existing system of electrification. It appears, however, that these companies wish to sell not only goods but engineering as well. Of course, a company can legitimately sell engineering advice as well as apparatus if this is what they are organized to do, but as railway men, we are interested in inquiring as to whether we are likely to get from this combination of effort the best results from railway construction and operating standpoints.

Now, I have testified to the excellence of the apparatus which these companies manufacture, but I cannot as unqualifiedly endorse their railroad engineering because they do not operate railways and they are not users of railway apparatus. Their railway engineering necessarily becomes tinged with commercialism and is, in the final anaylsis, merely the individual opinion of employees whose primary duty it is to sell factory product. It may be said that their representatives, being in constant touch with the market all over the country, are in a position to hear of troubles with apparatus in a more comprehensive manner than that of any outside engineer. To a large extent this, of course, is true as regards the weak points of apparatus which they manufacture. But is not true as regards the operating efficiency of a system as a whole, which depends upon many other things. I appreciate that these large companies have been more or less driven into the engineering by the lack, in the early days of electric development, of practical operating experts, but today when this condition has radically changed it would seem that these companies should recognize their proper functions, and coöperative with operating engineers instead of attempting to absorb a field which is really foreign to their manufacturing functions.

I might cite a specimen of manufacturing engineering; before an engineering society recently a paper was delivered upon railway electrification, purporting to be a purely professional review of the present status of the question. But when analyzed it was found to be nothing more than a case of special pleading from the salesman's viewpoint for a certain electric system which one of the manufacturing companies is exploiting. There was no weighing of the various advantages and disadvantages of different systems; instead, broad claims were made for one system as possessing all the virtues and as broad condemnation expressed or a rival system as having no merit. If the paper had frankly stated that its real object was the sale of particular apparatus, I suppose we could not expect emphasis on its weak points. But in all events in presenting what is purported to be the present status of heavy electric traction, neither hearsay statements should be advanced as fact nor information suppressed as to the extent of use of other systems.

The important point of all this is that such papers have a very bad influence on the legitimate extension of electric traction and from such a standpoint we have a right to protest against them. Electric traction is a rapidly developing art and there are several systems under trial, each of which will be found to have its legitimate field of applications and limitations. The real battle of the systems must be fought in the practical analysis and trial of these systems, which is now under way.

To conclude, we want the coöperation of the manufacturing companies. We want them to exercise the highest engineering skill, as in the past, in developing apparatus of greater flexibility, durability, efficiency and lower first cost. We do not need them to tell us what assemblage of apparatus, method of installation and operation are necessary to best results under conditions we are more familiar with than they. We certainly do not want them to befog the real status of electric traction either as to system or economic results.

Valuation for Rate Making; Discussion before the American Society of Civil Engineers

An adjourned meeting for the further discussion of the preliminary report of the Valuation Committee of the American Society of Civil Engineers was held at the house of the Society, in New York City, on the afternoon and evening of Apr. 2. The thread of discussion was taken up as left off on Mar. 11, as noted in ENGINEERING NEWS, Mar. 19, 1914. The attendance naturally was not as large as before on account of opening the meeting in the afternoon and with some uncertainty of it being continued through the evening. The discussion, however, was vigorous.

As before, the discussion largely centered on the section of the Committee's preliminary report relating to depreciation. There was, as before, much comment on the inadvisability of discussing valuation for rate-making purposes at this time, although such remarks were hardly a discussion of the report itself.

Prof. Geo. F. Swain (Harvard University) argued that an utility customer's only interest in the allowance in rates for depreciation (figured according to the sinking-fund method) is to secure the minimum amount necessary to cover replacements, etc. Then the rate payer has no further concern except as being a citizen or an investor. He contended that, for settled public utilities, a depreciation reserve fund was needed only to absorb the inequalities of annual renewals. He believed that the term "depreciation" had been confusedly used by the Committee in two ways; (1) as the loss in value from wear, and (2) as the lesser price at which property can be purchased. In discussing the Committee's proposition that it was unfair to relieve the company of the risk of any decrement of value while allowing them every unearned increment, he argued that depreciation due to wear was essentially different in nature from the natural appreciation of land, so that the two could not be set off against each other. He agreed that original cost formed a good criterion of value, but that it was not available in railway valuation so that reproduction estimates had to be substituted. Therefore, valuation should be made once for all as a fresh starting point, and should not be a process to be repeated at intervals. On this account, the cost of reproduction new was to be found and not a depreciated value. The effort of the Committee, it seemed to him, was an attempt to reverse this order; depreciated value had been accepted as the starting point and the adjustment of annual depreciation allowances made to secure equity in accordance. This would be satisfactory if there was assurance that the U. S. Supreme Court would never reverse the Knoxville decision. This reversal he expected to see, if engineers would insist on the use of reproduction new as a basis.

He gave data for an interurban electric railway ten years old, now earning 12% net, and paying 8% in dividends with 4% annual surplus for depreciation and renewals, which keep the maintenance in stable equilibrium. The net earnings in the first few years were low and had all been paid out in dividends, so that in ten years there was accumulated only 12% total depreciation reserve. He claimed that, if the records should be lost and a valuation made, the cost to reproduce would be found as the original cost, $1,000,000, while the de-

preciated value would be $720,000, on which according to the Committee the rate should be based. (He neglected, however, inclusion of the early deficit, between what was earned and the desirable 12%, in development expense, which the Committee report would allow, bringing the total value back up to the $1,000,000.)

D. W. Lum (Special Engineer, Southern Ry., Washington, D. C.) protested against the presentation of such a report on rate-making at this time. He admitted the eminence of the members of the Committee and the influence of the Society, and believed that all wished to have no unjust situations created. He could not see how the Committee's methods harmonized with present practice and he would have preferred that it had stuck to its instructions and to the Federal law governing appraisal of common carriers' property for no specific use. He argued for "service value" (ability to function) as a basis for rates, and replacements included with operating expenses

J. N. Dodd (Assistant Electrical Engineer, Public Service Commission, First District, New York City) contended that the value to be arrived at should be the cost of the plant of a possible competitor—involving the substitution of the most modern construction and equipment for that existing

C. R. Harte (The Connecticut Co., New Haven) called attention to the desirability of having uniform nomenclature and cited as an instance the confusion existing when "depreciation" was spoken of. He could not see that physical value was of necessity the basis of rates. He would substitute the inherent value of services rendered. He was not satisfied with the Committee's view in regarding depreciation allowances as a return of investment to the company.

Samuel Whinery (Consulting Engineer, New York City) objected to the term "depreciation," holding that the conflicting views of it were in conflict through misunderstanding of its use. The idea of annuities was not covered by "depreciation," as ordinarily understood outside of the profession, nor was the cost of maintenance there. What was really understood as "depreciation" was a diminished value determined by appearance and not from any probability of life or actual experience. He would like to see the whole vocabulary of valuation discussions reduced to terms commonly understood in general use.

Martin J. Schreiber (Engineer of Maintenance-of-Way, Public Service Electric Ry., Newark, N. J.) spoke for the Committee on Life of Property of the American Electric Ry. Association. He said that this body had access to the records of most of the large electric railways of the country and offered its data to the American Society Committee. The members of this electric-railway committee had at first thought that provision for depreciation in electric-railway property could be satisfactorily made in accordance with the schemes of the American Society Committee, but that on practical application they were unsatisfactory. Therefore the members reverted to the renewal scheme. Mr. Schreiber read the finding of the railway association committee's last report. This was that the elements which caused differences in life of similar apparatus (use, climate, maintenance, adequacy, obsolescence, human factor, public demand, earnings, etc.) were so complex that no tables could be drawn up for useful life, and that probable life in any case was to be fixed by careful survey (see ENG. NEWS, Oct. 23, 1913, p. 841).

M. L. Byers (Special Agent, Delaware & Hudson R. R., New York City) admitted the utility of the "fair value-fair return" theory of rates for water-works and gas plants, which sold a single product, but he asked the Committee to work out more in detail the application of that scheme to railway tariffs. He feared difficulties; for instance, fair value and fair return must be the average of a future period in which the service would vary with the tariff and must be forecasted. Railway carriage was a complicated service not comparable with the single product of gas and water-works. Railways must recognize that homes and factories have already been built at what are economic points under the present railway rates. The substitution of a "fair value-fair return" scheme would affect millions in investment.

H. M. Stone (Assistant Engineer of Valuation; Chicago, Rock Island & Pacific Ry., Kansas City) presented a written discussion, arguing that the Committee's principles did not apply to railways under competitive conditions. He also failed to find any provision in the general premises of the Committee for contingent funds. He would provide for depreciation by making renewals a part of operating expense, and let unusual replacements, like large buildings, be covered by temporary expedients. He preferred the consistent use of reproduction costs new instead of admitting the influence of history. He did not see how the appreciation of land could be used directly to offset depreciation of plant.

J. H. H. Muirhead (Glasgow, Scotland) asked for clear definitions in the report and urged the segregation of municipal and public stock corporations for rate discussions. He held that 8% was not ample repayment for the early risks in railroad construction or the present operating risks. He would include in value capitalized franchises and the cost of preserving railroad interests from adverse legislation (lobbies).

Gardner S. Williams (Consulting Engineer, Ann Arbor, Mich.) pointed to depreciation as the great stumbling block in valuation. He found no definition approaching the subject from the right angle and argued that depreciated value was not "service value." He defined depreciation as "the difference between present worth of future service of a new article and of the article in question." He claimed that the Committee had not allowed for the element of "brains" in its approach of value; much of what was called "water" in present stock issues was "capitalized brains."

The Committee's replies to the criticisms will be abstracted in next week's issue of ENGINEERING NEWS.

Motor Bus Extensions of Street Railway lines are contemplated in Cleveland, Ohio. A resolution authorizing the purchase of three busses, to cost $16,251, has been presented to the City Council. Each bus will seat 26 people. It is planned to put the first one in service at the end of the St. Clair Ave. line running to the eastern limit of Nottingham—Report of Peter Witt, Street Railway Commissioner, to City Council, Mar. 23, 1914.

An Ohio River Bridge at Portsmouth, Ohio, is being considered by the Chesapeake & Ohio Ry. Co. It is contemplated to construct a connection from the present Chesapeake & Ohio line opposite Portsmouth across the Ohio and to Columbus, O., in conjunction with the Hocking Valley Ry. Surveys are at present being made with a view to selecting the site for a bridge and preparing further preliminary plans. C. A. Wilson, Cincinnati, is Consulting Engineer to the railway company.

Caisson Accident, Memphis Bridge

[Special Dispatch to "Engineering News" from M. B. CASE, Resident Engineer.]

Nine men lost their lives on Apr. 5, at the bottom of the main shaft in caisson No. 5, on the Arkansas end of the J. T. Harahan Bridge now building across the Mississippi River, at Memphis, Tenn. Eight of the nine men, comprising one of the six gangs of caisson workers engaged on this pier, were on their way into the caisson to relieve their companions, when presumably they were overcome by gas which had accumulated at the bottom of the open vertical shaft leading down from the top of the caisson to the air lock 10 ft. above the working chamber. About 15 minutes after these men had passed down the shaft a signal was received on top from the gang in the working chamber asking why they were not being relieved. Upon receipt of this, the outside lock tender and sinking superintendent started down the shaft to ascertain the trouble. When about 30 ft. from the bottom of the shaft, the lock tender said he saw the men piled up at the bottom and immediately thereafter lost his hold on the ladder and fell. The superintendent regained the surface and brought out the gang from the working chamber one by one in the clay-hoist bucket through one of the material locks.

Efforts were made immediately to recover the men in the main shaft. A high-pressure air line was let down into the shaft to drive out the gas; and the bodies of the men were recovered by aid of men equipped with diving suits and helmets. The caisson had been sunk about 85 ft. below the surface and was nearly ready to seal. Immediately upon recovery of the men in the working chamber, the caisson was flooded and the air pressure taken off.

The origin of the gas has not yet been determined. Some of the men who left the working chamber through the material locks said that the oakum in the roof of the chamber near the air-supply pipe was afire. The divers reported the heat to be intense near the bottom of the main shaft. Two men who had passed through the lock and out up the same shaft about 15 minutes before the accident said they did not notice any gas in the shaft.

Steel Bridge Span Injured; Later Falls with Train

[Telegraphic Report from ALBERT SMITH, Professor of Structural Engineering, Purdue University, Lafayette, Ind.]

A serious bridge accident occurred Sunday, Apr. 5, on the main line of the Wabash R.R. at Attica, Ind., where the line crosses the Wabash River. The crossing is a steel bridge 1800 ft. long, the easterly portion composed of six Pratt truss through spans 110 to 150 ft. long, and the westerly portion of 12 plate-girder spans. Attica station is just east of the bridge, about 300 yd. away; the track approaches the bridge on curve.

About noon Sunday, as a westbound freight train was entering on the bridge, a refrigerator car in the middle of the train derailed on the curve. It struck the left-hand end post of the easterly span and bent it 10 in. out of line. The span did not fail, however, and the derailed car ran along as far as the third span. From here the freight engine pushed it back to the east end. The damaged span carried this engine, weighing 2[illegible] tons with tender, satisfactorily. The supervisor of t[illegible] watched the bridge from below while the engine cr[illegible]d and reported that no yielding of the bridge was pe[illegible]ptible.

During this time the "Continental Limited," eastbound, due at Attica 1.53 p.m., had been waiting at the west end of the bridge. When the bridge was cleared of the freight train the limited crossed, running slow. Just as the pilot truck of the passenger locomotive was over the abutment, the damaged south truss slowly went down. In its failure , it carried the north truss with it, and dropped engine and tender on the river bank. The mail car back of the tender was also on this span; pitching forward against the tender, its end was thrown to the north, and threw the combination coach (behind the mail car) against the north end-post of the second span, wrecking this span and dropping the combination coach into the river. The westerly four panels of this span, containing a passenger coach, remained leaning against the second pier.

All cars of the train were of steel. The engineer, the fireman and the express messenger were killed, and 35 persons were injured, six of them seriously.

NEWS NOTES

A Severe Fire in St. Augustine, Fla., on Apr. 2, destroyed five hotels and several other buildings. No lives were lost.

Buffalos Derailed a Train in Java, on Apr. 2, about six miles from Batavia, killing 20 natives, and injuring 50 others.

A Locomotive Boiler Blew Up, on the Philadelphia & Reading Ry., at Fanwood, N. J., on Apr. 1. The engineer and the fireman were injured by escaping steam.

A Heavy Landslide at Brive, France, obliterated a number of farms and cottages, and the roads in the vicinity for about a mile, on Mar. 29.

A Storm Sewer Pierced by a Bridge Pile during the construction of the temporary High-Main St. Bridge, at Hamilton, Ohio, caused a number of flooded cellars after a rain on Mar. 28.

A Cocoa-Dust Explosion in the factory of the Massachusetts Chocolate Co., in Roxbury, Mass., on Mar. 30, caused the walls of the room to collapse, injuring a number of girl employees.

Both Sides of a Sewer Trench Caved In, at St. Louis, recently, burying six men engaged in shoring it. Four of the men were injured. The trench was 16 ft. deep.

A Suspension Bridge Failed on Mar. 28, near Fresno, Calif., while an automobile was crossing. The five occupants of the car were plunged into the San Joaquin River (Calif.) about 50 ft. below, and were drowned.

Driftwood Wrecked a Temporary Wood Bridge over the Big Miami River, connecting Middletown, Ohio, with West Middletown, on Mar. 28. A large log lodging against the bridge, collected driftwood until the middle span, about 175 ft. long, gave way. The remainder of the structure was saved by directing driftwood through the opening.

A 12-In., 8-Ft. Pipe-Trench Wall Collapsed in the Flatbush Theater, under construction on Church Ave., Brooklyn, N. Y., on Apr. 3, killing three laborers and seriously injuring a fourth. The trench surrounded the orchestra section. Its inner walls were intended ultimately to carry the orchestra floor and were therefore shored when they were built. According to P. J. Carlin, building superintendent of the Borough of Brooklyn, at 2:30 p.m., the supervising architect for the theater ordered that the trench be cleaned up and the shoring removed. Four laborers entered the front pit and shortly afterward the front trench wall, behind which was piled about 10 ft. of dirt, fell over, crushing the men against the stage wall opposite. Robert Rasmussen, supervising architect for the building, was arrested shortly after the accident on a charge of criminal negligence, and released on $5000 bail.

A Break in the 40-In. Main of the Baltimore Water-Works just outside the Mount Royal pumping station occurred about Mar. 1, making it necessary to shut down the station for a few days. In response to an inquiry regarding this break, Ezra B. Whitman, Water Engineer of Baltimore, writes as follows:

This work was all flanged work and the special that broke was a Y-branch receiving the discharge from one of the pumping units. Considerable difficulty was experienced in getting this flange joint tight and I believe that in making this joint tight a very considerable initial strain was introduced into this Y-casting by the drawing up of the bolts. The pulsation of the pump kicking against this Y-branch with the metal in a strained condition is what I believe caused the final cracking of this casting.

Commenting further upon the break and in answer to a question as to whether in his opinion breaks in water mains are increasing or decreasing in Baltimore, Mr. Whitman writes:

The conditions in this city in regard to the breaks in water mains are very different at the present time from what they were before the Sewerage Commission started work laying the sewers. In practically all cases the sewers are laid much deeper than the water mains, and many of our recent breaks are in the old trenches of the Sewerage Commission. This condition is a very natural one and was to be expected, for no matter how carefully the work of the sewer contractors may have been done, in many cases it is practically impossible to prevent some settlement, and settlement of the cast-iron pipe, of course, makes a break if it is not placed in such a position that the lead in the joints will give.

Fixed Bridges Over the Chicago River, in place of drawbridges, are to be the subject of an inquiry by a committee of the Chicago Real Estate Board. The adoption of such a policy would limit the river navigation to barges and tugs.

Refuse Destructors for the garbage and presumably the other refuse of New Orleans, La., with the incidental production of electric energy, are under consideration but nothing has yet been definitely decided. The matter is in charge of E. E. Lafaye, commissioner of Public Property.

Reconstruction of the Brooklyn Bridge has been studied out by the Department of Bridges, New York City, in detailed studies during the past ten years. The project has now been taken up by the new Commissioner of Bridges, F. J. H. Kracke. The work in question is likely to mean the entire replacement of all the suspended structure; that is, everything except towers, tower cables, and anchorages. The existing stiffening trusses and floor are not adequate for permanent service under present overloading, and give no additional capacity for the further loading which the bridge might be made to carry.

Completion of the Grand Trunk Pacific Ry.—The last spike on the main line of the Grand Trunk Pacific Ry. was driven at noon, Apr. 7, near the Nechaco River, at Fort Frazer, B. C., 220 miles east of Prince Rupert, B. C. It is expected the railway will be in operation in August from Portland, Maine, to Prince Rupert. A southern branch now under construction will give connection with Vancouver, B. C.

A City Planning Competition for laying out 300 acres of land in the heart of Richmond, Calif., a new seaport near San Francisco, is announced. The program for the competition may be obtained from Lewis P. Hobart and Charles H. Cheney, associate architects and advisors to the Richmond Canal Subdivision Co., Crocker Building, San Francisco. Competitors should take notice that the prizes offered are land valued at $10,000.

An International Competition for Building Designs is announced for the construction of a group of summer residences on the Lido, the sandy island fronting Venice (Italy). Prizes of $2400, $1600 and $1000 are offered for the best designs, which must be submitted by June 30. The designs will be passed upon by a commission of seven members including Giovanni Bordiga, President of the Venetian Society of Engineers. Information may be obtained from the Compagnia Italiana dei Grandi Alberghi, of Venice.

The Repair of the Stony River Dam, near Dobbin, W. Va., a section of which was washed out on Jan. 15 last ("Engineering News," Jan. 22, 1914, p. 211) is now under consideration by the owner, the West Virginia Pulp & Paper Co. Under the direction of F. W. Scheidenhelm, Consulting Engineer, Pittsburgh, Penn., who has been retained by the paper company, investigations are now under way looking into the advisability of making the repairs, and the method of making them, if they are found to be desirable or possible.

A Divining-Rod Case—A well is now being bored in the Hill Bldg., 36th St. and Tenth Ave., New York City, which was located successfully by von Uslar, a German "dowser" or "rhabdomancer," who has recently come to this country. The drilling was undertaken by a driller who guaranteed to locate and tap water in a certain quantity, and brought the medium to do the locating. Exploring the boiler room with a metal "twig" between fingers and thumbs, at a certain point he felt the twig turn, and predicted a stream of water at depth 113 ft. 3 in. below curb, flowing west (toward the Hudson River). The driller thereupon put down a 2-in. core-drill hole at this spot, and struck water 114 ft. below curb. An 8-in. hole is now being drilled alongside the 2-in. The rock is Manhattan schist, striking a white rock at 115 ft. below curb, or 75 ft. below boiler-room floor.

The Tennessee River Bridge on the line of Market St., at Chattanooga is to be built under the direction of B. H. Davis, Assoc. M. Am. Soc. C. E., of New York City. Mr. Davis has been selected for the work by the Tennessee River Bridge Committee, which has charge of the design and construction of the bridge. This commission advertised for competitive designs for the bridge early this year, and held a hearing on Feb. 18 at which some nine engineers and engineering companies presented their designs and claims for consideration as engineers for the structure. Mr. Davis was one of the engineers presenting designs, but we do not understand that he is to be restricted to the design which he submitted. He is, rather, appointed engineer for the bridge with full power over design and construction, subject to the committee. The design submitted by Mr. Davis is for a 1900-ft. bridge, 50 ft. wide, made up of six 160-ft. concrete arches with a center rolling-lift bascule of from 200 to 300 ft. span. The bridge is estimated to cost $500,000. (See "Engineering News," Feb. 5, 1914, p. 313; Mar. 5, 1914, p. 541).

Chains for Lock-Gate Protection, Panama Canal—Great difficulty is being found in getting satisfactory strength in the immense chains now under construction at the Boston Navy Yard for the lock-gate protection of the Panama Canal. These chains and their hydraulic operating machinery are an innovation in canal lock design and operation. They are designed to be stretched across the locks in front of vessels to arrest the momentum of a ship which, for any reason, gets beyond the control of the electric towing locomotives. The chains are made of 3-in. diameter wrought iron; the links are 17 in. long by 10¾ in. wide. The 24 chains necessary have an average length of 427 ft. each and weigh 85 lb. per ft. Great differences in the strength of different links have been found, mostly in the welds where the breaks in the chains tested generally occur. All links are tested to about 275,000 lb. The breaking loads have run from $12,000 to 560,000 lb. Open links appear to be stronger than stud links, in general, but they elongate much more. The parts of the chain which will run over the sheaves of the hydraulic operating machines have open links, while the parts which will span the locks have stud links. The testing of the chains is under the general charge of J. Hammer, Assistant Engineer, Isthmian Canal Commission, Pittsburgh, Penn.

Last of the Dry Excavation, Culebra Cut, Panama Canal—The dry excavation for Culebra cut was terminated on Mar. 31, when the three 95-ton steam-shovels engaged in lessening the pressure on the east Culebra slide, north of Gold Hill, were withdrawn from their pits and made ready for dismantling. The crews of the shovels and of the dump trains which have handled their spoil were discharged, effective Apr. 1, on account of reduction of force. Dry excavation at the bottom of the cut was discontinued on Sept. 10, 1913, on which date 13 steam-shovels were engaged on high levels at various points. The number has since been gradually reduced as the work was completed. In the latter part of November, six shovels remained; two of these, on the west bank at Culebra, were withdrawn in December. Since that time, the dry excavation has been confined to the Gold Hill slide. Four shovels were working until the latter part of February, when one was withdrawn. The completion of the dump near the New Culebra station, on which the spoil was wasted, and the general condition of the Gold Hill slide, have led to the decision to abandon the use of all the steam-shovels. ["Canal Record."]

A Sanitary Investigation Board for Chicago has been appointed by the Chicago Real Estate Board (through its River and Harbor Committee) to investigate and report upon the proper future policy of the city in regard to water supply and sewage disposal. The board will consist of George A. Soper, President of the Metropolitan Sewerage Commission of New York; Arthur J. Martin, of London, past president of the British Sanitary Institute; and a member of the late firm of Cameron, Commin & Martin, which exploited the septic tank, and James D. Watson, of Birmingham (England), president of the Institute of Sanitary Engineers, and for many years Chief Engineer of the Birmingham, Tame & Lea Dis-

trict Drainage Board. The reason for engaging foreign experts is to secure men of large experience who have had no previous connection with the Chicago problem and have no bias or set opinions due to such connection. In a report of the committee, announcing its action, it is stated that such a study is of great importance in view of the statement by the president of the Sanitary District of Chicago that the city faces a possible expenditure of $200,000,000 for further sanitary protection in case the suit for an additional draft of water from the lake for the drainage canal is decided adversely to the District.

Bids for an Intercepting Sewer and Imhoff Tanks at Albany, N. Y., will probably be received late in May or early in June. The intercepting sewer will be of concrete and will range in size from 24 to 66 in. in diameter, and the length of the sewer will be about three miles. The Imhoff tanks will be part of disposal works located on Westerlo Island opposite the south end of Albany. The island is separated from the shore by a small stream channel known as Island Creek. The sewage works have been designed to take care of an average daily sewage flow of 30,000,000 gal. Before the sewage reaches the Imhoff tanks it will pass through grit chambers and coarse screens. There will be four sets of Imhoff tanks, each consisting of four individual tanks 33x98 ft. in plan and 29 ft. deep. Provision is made for reverse flow. A pumping station will be required. Bids for the grit chambers, screens and pumping stations will not be called for until next year. Plans for the intercepting sewer have been prepared by Stephen B. Vernon, engineer intercepting sewer design and construction, Bureau of Engineering, of the city of Albany. The plans for the disposal works were made by Hering & Gregory, consulting engineers of New York City. Mr. Vernon will have charge of the construction work outlined above. Frank R. Lanagan is city engineer of Albany.

A New Water-Works Plant for Vicksburg, Miss., is to be built after a legal struggle between the city and the local water-works company. After years of litigation between the city and the company the city decided to build new works to be ready for use at the expiration of the company's franchise in 1916. For this purpose a bond issue of $400,000 was authorized by a large majority at a popular election. The water company obtained an injunction from the United States District Court, restraining the city from selling the bonds or doing anything toward building a new plant during the life of the franchise. The injunction was sustained by the U. S. Court of Appeals, but was overruled by the U. S. Supreme Court, thus leaving the city free to build water-works whenever it pleases. The city offered the company $200,000 for the works of the latter, with a time limit. The company made no response to this offer. The city has engaged A. L. Dabney, chief engineer of the Dabney Engineering Co., Memphis, Tenn., to make plans and specifications for the new water-works and to supervise their construction. Surveys have been started and it is expected that the new plant will be ready for use at the expiration of the franchise of the company in 1916.

A New Plan for Garbage and Refuse Collection and Disposal at Chicago has been recommended by Irwin S. Osborn, of Toronto, and John T. Fetherston, of New York City, in a report to the Chicago City Wastes Commission, of which Health Officer Young is chairman. The engineers recommend that the city install and operate collection, transportation and disposal systems, improving such of these as it now has; that garbage, ashes and refuse be separated by householders, and that the present rules to that end should be enforced; that the city be divided into 11 collection districts; that garbage be collected by teams, hauled to the nearest district loading station, transferred there to motor trucks (with the exception noted below) and hauled to a central garbage-reduction plant; that refuse be hauled to each district loading station, marketable wastes sorted out and the remaining combustible wastes burned; that two southern districts be served by a combined garbage and rubbish high-temperature incinerator, located at Stony Island Ave. and 95th St., and that ashes be hauled by teams and in some localities by street cars and used for filling, preferably on land owned by the city. The total cost of the plant is put at $3,513,000; annual cost of operation and maintenance, $2,662,000; annual receipts from grease, tankage, lighting, etc., $726,000. A technical staff to design and install the plant, to operate it for at least one year and to continue the study and analysis of the wastes of the city is advised; and for this purpose it is recommended that $85,000 of the estimated construction cost just named be made available for the first year of investigation.

The city has 3000 miles of streets and 1500 miles of alleys, a large proportion being unimproved. The collections in 1913 averaged 98 lb. of garbage per capita and 555 lb. of ashes and rubbish per capita. There are 143 portable paper burners in 39 wards, which are effective, but less so than removal as there is complaint about smoke and odor. They are iron baskets on wheels, 11 to 17 cu.ft. capacity. An analysis of 11[illegible]000 lb. of material collected in January and February, 1914, showed the following: Fine ash, 49.88%; coal cinders, 34% clinkers, 11.59%; glass, 0.97%; metals, 0.87%; rubbish, 1.[illegible]%; garbage, 0.99%.

PERSONALS

Messrs. Howard R. Green and Hugo Layer announce the formation of the firm of Green & Layer, Engineers, Cedar Rapids Savings Bank Bldg., Cedar Rapids, Iowa.

Mr. Paul F. Rossell, Jun. Am. Soc. C. E., of Wilmington, Del., has left this country for China, where he has accepted a position with a railway contracting company.

Prof. Frank Irvine, Dean of the faculty of law, Cornell University, has been appointed a member of the Public Service Commission, Second district, of New York State.

Mr. D. R. Morris has resigned as Signal Engineer of the El Paso & Southwestern Ry. System, El Paso, Tex., to accept a position with the Federal Signal Co., of Albany, N. Y.

Mr. L. W. Longan, formerly connected with the Chicago and Indianapolis works of the Link-Belt Co., has been placed in charge of the company's newly opened Detroit, Mich., office, in the Dime Bank Bldg.

Mr. Herbert E. Correll, formerly Trainmaster of the Chicago, Rock Island & Pacific Ry., at Eldon, Mo., has been promoted to be Superintendent of the St. Louis division, with headquarters at Eldon.

Mr. J. S. Sheafe, recently Engineer of Tests of the Illinois Central R.R., is now Master Mechanic of the Staten Island lines of the Baltimore & Ohio R.R., at St. George, Borough of Richmond, New York City.

Dr. Haven Emerson, Assistant Professor of physiology and medicine at Columbia University, has been appointed Sanitary Superintendent of the New York City Department of Public Health, with a salary of $5000 per annum.

Mr. J. E. Roberts, formerly Superintendent of the Napierville Junction Ry., at Lorel, Que., has been appointed General Superintendent of the Greenwich & Johnsonville Ry., with office at Greenwich, N. Y., succeeding Mr. T. J. Lynch, transferred.

Mr. Elliott H. Whitlock, M. Am. Soc. M. E., Factory Manager of the National Carbon Co., Cleveland, Ohio, has opened an office at 1506 West 112th St., Cleveland, as Consulting Engineer, specializing as a carbon expert and in efficiency management.

Mr. John G. Walber, recently assistant to the Third Vice-President of the Baltimore & Ohio R.R., Baltimore, Md., has been appointed Secretary of the newly organized Bureau of Information of the Eastern railways, with offices in New York City.

Mr. D. H. Goodwillie, former Superintendent of Filtration and recently Superintendent of the Water Department of Toledo, Ohio, has resigned to become associated with Mr. William G. Clark, Consulting Engineer, 1047 Spitzer Bldg., Toledo, Ohio.

Mr. S. B. Bennett has been appointed Engineer of the Board of Works and Waterworks of the Corporation of the District of South Vancouver, B. C. Mr. Bennett writes that this district, comprising 9000 acres, already has a population nearing 40,000.

Mr. Theodore Speiden, Jr., formerly Roadmaster of the Louisville & Nashville R.R., Nashville, Tenn., has been promoted to be Assistant Superintendent of the Chattanooga division of the Nashville, Chattanooga & St. Louis R.R., at Nashville, Tenn.

Mr. Robert S. Jones, Assoc. M. Am. Soc. C. E., has resigned as Chief Engineer of the James Westwater Co., Engineers and Contractors, Columbus, Ohio, to become Division Engineer on construction of the new mechanical filtration plant at Cleveland, Ohio.

Mr. Hiram M. Kochersperger, Vice-President of the New York, New Haven & Hartford R.R., in charge of finance and accounting, has resigned. He has been granted leave of ab-

sence until July 1, when he may take advantage of the company's pension rules.

Prof. Charles F. Burgess, for a number of years in charge of the chemical and applied electrochemical departments of the University of Wisconsin, has resigned to become Manager of the Northern Chemical Engineering Laboratories, with offices at Madison, Wis.

Mr. P. C. Allen, recently on the staff of the Superintendent of Transportation of the Baltimore & Ohio R.R., Baltimore, Md., has been promoted to be Superintendent of the Philadelphia division, at Philadelphia, Penn., succeeding Mr. J. T. Olhausen, assigned to other duties.

Mr. Hunter McDonald, President of the American Society of Civil Engineers and Chief Engineer of the Nashville, Chattanooga & St. Louis R.R., is being urged by the Tennessee delegation in Congress for the office of Chief Engineer of the government railroad to be built in Alaska.

Mr. C. W. Pifer, Consulting Engineer, of Dubuque, Iowa, has been appointed Senior Civil Engineer of the Central district, Division of Valuation, Interstate Commerce Commission, with headquarters at Chicago, Ill. Mr. Pifer was formerly with the engineering staff of the Illinois Central R.R.

Mr. R. C. White, Assoc. M. Am. Soc. C. E., formerly General Roadmaster of the Southern district of the Missouri Pacific Ry., at Wynne, Ark, has been promoted to be Engineer of Maintenance-of-way of the same district, with headquarters at Little Rock, Ark., succeeding Mr. Hugh E. Hale, resigned, as noted elsewhere.

Mr. W. P. Thornton, for many years with the engineering staff of the Riter-Conley Co., Pittsburgh, Penn., has resigned to accept a position with the Treadwell Construction Co., Pittsburgh. During the erection of the eight large blast-furnaces of the United States Steel Corporation at Gary, Ind., Mr. Thornton was Engineer in charge.

Mr. Charles A. Moreno has resigned as Sewer Commissioner of St. Louis, Mo., to accept a position with an engineering and construction firm of Chicago, Ill., the name of which has not yet been announced. Newspaper reports state that his salary is to be $12,000 per annum as against $4000 he receives from the city as Sewer Commissioner.

Mr. C. S. Lake, recently General Superintendent of the Chicago & Alton R.R., at Chicago, Ill., has been appointed General Superintendent of the Seaboard Air Line Ry., with headquarters at Portsmouth, Va. Mr. Lake was formerly Division Superintendent of the New York, New Haven & Hartford R.R., and General Superintendent of the Minneapolis & St. Louis R.R.

Mr. James L. Davis, Assoc. M. Am. Soc. C. E., formerly Assistant Engineer, Board of Water Supply, City of New York, recently Section Engineer in charge of the construction of the Bryn Mawr siphon and the Yonkers pressure tunnel, has been appointed Supervisor of Highways and Highway Engineer of Bennington County, Vermont, with headquarters at Manchester, Vt. The appointment of an engineer to this position is the result of agitation by a county improvement association.

The Illinois Central R.R. announces the following promotions: Mr. D. J. Brumley, M. Am. Soc. C. E., Assistant Chief Engineer, is appointed Valuation Engineer; Mr. F. L. Thompson, Engineer of Construction, is promoted to be Assistant Chief Engineer; Mr. A. F. Blaess, District Engineer at Chicago, Ill., is promoted to be Engineer of Maintenance-of-way; and Mr. P. Laden, former Division Superintendent and recently engaged in special work for the Grand Trunk Ry., has been appointed District Engineer of the Northern lines, with headquarters at Chicago.

Mr. J. B. Berry, M. Am. Soc. C. E., Assistant to the President of the Chicago, Rock Island & Pacific Ry., Chicago, Ill., has resigned. It is reported he will engage in private practice as Consulting Engineer, specializing in railway valuation, with headquarters in Chicago. After 15 years in the engineering department of the Chicago & Northwestern Ry. he was made Chief Engineer of the lines west of the Missouri River in 1893. For eight years following he was Chief Engineer of the Union Pacific R.R. From 1905 to about a year ago he was Chief Engineer of the Chicago, Rock Island & Pacific Ry.

Mr. Julian Kendrick, M. Am. Soc. C. E., for many years City Engineer of Birmingham, Ala., has been reappointed City Engineer, succeeding Mr. Maury Nicholson, M. Am. Soc. C. E., who has been Acting City Engineer since the resignation of Mr. Walter G. Kirkpatrick, M. Am. Soc. C. E., noted in our issue of Dec. 11, 1913. Mr. Kendrick was City Engineer from 1891 to 1907, when he resigned to become Chief Engineer of the Rudolph S Blome Granitoid Concrete Block Paving Co., of Chicago, Ill., which position he resigned Jan. 1, 1913. Since then he has been in private practice in Birmingham. While City Engineer of Birmingham Mr. Kendrick designed the city's sewerage system and had charge of the construction of the greater part of it.

Mr. P. J. Kearny, M. Am. Inst. E. E., of McHenry & Murray, Consulting Engineers, New Haven, Conn, has been appointed Electrical Engineer of the New York, New Haven & Hartford R.R., reporting to Mr. W. S. Murray, F. Am. Inst. E. E., whose appointment as Consulting Engineer in general charge of all electrical engineering and construction was noted in our issue of Mar 19. Mr. Kearny graduated in mechanical engineering from the Massachusetts Institute of Technology in 1903, and after a post-graduate course and two years as an apprentice with the Westinghouse Electric & Manufacturing Co., he was appointed Assistant to the Electrical Engineer of the New York, New Haven & Hartford R.R. in 1906. Subsequently he was promoted to be Assistant Electrical Engineer.

Mr. Hugh E. Hale has resigned as Engineer of Maintenance-of-way of the Southern district of the Missouri Pacific Ry., Little Rock, Ark., to become Engineer for the Presidents' Committee on Valuation, Eastern group, with offices in New York City. Mr. Hale was born in Minnesota in 1874 and received his technical education at Lehigh University. He was with the engineering staff of the Pennsylvania R.R. until 1902, when he went to the Baltimore & Ohio R.R., first as Assistant Engineer and afterward as Division Engineer at Philadelphia, Penn. For three years he was Engineer of Maintenance-of-way of the same railway at Baltimore, Md. He went to the Missouri Pacific Ry. in 1908 as Assistant Engineer at St. Louis, Mo. Later he was Engineer of Design, Principal Assistant Engineer and Engineer of Maintenance-of-way.

Mr. W. B. Wood, Superintendent of the Cleveland & Pittsburgh division of the Pennsylvania Lines West of Pittsburgh, at Pittsburgh, Penn., has been appointed General Manager of the Grand Rapids & Indiana Ry., succeeding Mr. J. H. P. Hughart, elected President, as noted elsewhere. Mr. Wood is a graduate of Sheffield Scientific School, Yale University, class of 1897, and entered the service of the Pennsylvania Lines the same year as a rodman in the Chief Engineer's office of the Pittsburgh, Cincinnati, Chicago & St. Louis Ry. Until 1906 he remained in the engineering department, resigning as Division Engineer of the Cleveland & Pittsburgh division of the Pennsylvania Co. to become Superintendent of the Richmond division of the Pittsburgh, Cincinnati, Chicago & St. Louis Ry. He was made Superintendent of the Cleveland & Pittsburgh division in 1912.

The Philadelphia & Reading Ry. announces the appointment of the following committees to coöperate with the Division of Valuation of the Interstate Commerce Commission in the valuation of the railway company's properties: Advisory Committee, Messrs. Theodore Voorhees, M. Am. Soc. C. E., Vice-President; Charles Heebner, General Solicitor, and William Hunter, M. Am. Soc. C. E., Chief Engineer. A Valuation Committee has been appointed as follows: Messrs. Charles Hansel, M. Am. Soc. C. E., of Charles Hansel & Co., New York City, Consulting Valuation Engineer, Chairman; Carl Tombo, Assoc. M. Am. Soc. C. E., of New York City, Principal Assistant Valuation Engineer; E. Y. Allen, Assoc. M. Am. Soc. C. E., of South Orange, N. J., Assistant Valuation Engineer; E. F. Sterner, Civil Engineer; William L. Kinter, Assistant General Solicitor, and W. H. White Comptroller.

Mr. J. B. Hutchinson, Assistant to the Vice-President of the Pennsylvania R.R., was retired Apr. 1, under the company's pension rules. He was 70 years old on Mar. 20, and has been continuously in the service of the Pennsylvania R.R. since June, 1863, or very nearly 51 years. Mr. Hutchinson graduated from the Polytechnic College of Pennsylvania in 1861 and began his railway experience two years later as a rodman in the construction department. He was promoted through various engineering grades to be Principal Assistant Engineer of the Columbia & Port Deposit R.R. in 1870. After seven years in this position he was appointed Assistant Superintendent of the same subsidiary of the Pennsylvania R.R., and continued in the operating department, being promoted through various positions to that of General Superintendent of Transportation of the Pennsylvania R.R. in 1893. In 1897 he was made General Manager, and in 1903 assistant to the Vice-President.

Mr. F. E. Bissell, M. Am. Soc. C. E., until recently Chief Engineer and General Superintendent of the Akron, Canton & Youngstown R.R., has been appointed Senior Civil Engineer, Division of Valuation, Interstate Commerce Commission, with headquarters at Chattanooga, Tenn. Mr. Bissell graduated in civil engineering at Cornell University in 1878 and

began his engineering experience as a rodman on the Missouri River improvement under the United States Engineer Department. Subsequently he was with the engineer corps of various middle western railways until 1890 when he went into the operating department of the Union Pacific R.R. as Superintendent of the New Mexico division. Later he returned to the engineering department as Chief Engineer of the construction department of the Denver & Gulf Ry. From 1897 to 1900 he was Assistant Engineer and later Chief Engineer of the Wheeling & Lake Erie Ry. From 1901 to 1907 he was Principal Assistant Engineer of Construction of the Lake Shore & Michigan Southern Ry.

Mr. B. C. Milner, Sr., President of the contracting firm of B. C. Milner Sons Co., Louisville, Ky., has been appointed Senior Civil Engineer of the Southern district, Division of Valuation, Interstate Commerce Commission, with headquarters at Chattanooga, Tenn. Mr. Milner is a graduate in civil engineering of the University of Georgia, class of 1882, and was in railway engineering work for various Southern railways, until 1903, when he was promoted from the position of Engineer of Maintenance-of-way of the Southern Ry. at St. Louis, Mo., to be Division Superintendent at Louisville. This position he resigned in 1907 to become General Manager and Chief Engineer of the Cumberland R.R., at Warren, Ky.

Mr. J. H. P. Hughart, formerly Vice-President and General Manager of the Grand Rapids & Indiana Ry., has been elected President, with office at Grand Rapids, Mich. Mr. Hughart has been with this railway continuously since 1874 when he was made Secretary to the President.

Mr. Edward Fuller Brooks, whose retirement as General Superintendent of the Philadelphia, Baltimore & Washington R.R., under the pension rules of the Pennsylvania R.R., of which it is a subsidiary, was for many years an engineering official of the company. He was born in 1848 and graduated from Rutgers College, New Jersey, in 1872. His service with the Pennsylvania R.R. began in August of that year as an assistant in the office of the Assistant Engineer of the New York division. He was successively promoted through various engineering grades and for ten years, 1883 to 1893, he was Engineer of Maintenance-of-way of the United R.Rs of New Jersey. He was promoted into the operating department in 1893, when he was appointed Superintendent of the Maryland division of the Philadelphia, Baltimore & Washington R.R., of which he was General Superintendent from 1899 until Apr. 1 last. Mr. Brooks' entire railway experience, covering nearly 42 years, has been with the Pennsylvania R.R. and its subsidiaries.

OBITUARY

Pierre Proal Huribut, a civil engineer of Atlanta, Ga., died Mar. 25. He was a member of the American Society of Engineer Contractors.

William Churchill Oastler, Assoc. Am. Soc. C. E., died at his home in New York City, Mar. 31. Mr. Oastler was born in Birmingham, England, 84 years ago. He is said to have been largely instrumental in the introduction of modern steel rails on English railways. Later he came to this country as the representative of railway supply and contractors machinery manufacturers and a generation ago had a wide acquaintance among engineers and contractors.

Francis Wiley Jones, M. Am. Inst. E. E., a retired electrical engineer, for many years connected with theW estern Union Telegraph Co., died Mar. 31 at his winter home at West Palm Beach, Fla. He was born in Nova Scotia and in 1872 entered the employ of the Western Union Telegraph Co., at Chicago, Ill. Mr. Jones is said to have adapted the quadruplex system of sending messages, then just invented by Thomas A. Edison, to the work of the Western Union. He also made many other improvements in the telegraph system. He was one of the founders and the first President of the New York Electrical Society.

ENGINEERING SOCIETIES

COMING MEETINGS

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
Apr. 16-17. Fourth annual convention at Atlanta, Ga. Chairman Local Committee, B. Frank Irwin.

AMERICAN ELECTROCHEMICAL SOCIETY.
Apr. 16-18. Spring meeting in New York City. Secy., Prof. J. W. Richards, Lehigh University, Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Apr. 22-25. Annual meeting at Savannah, Ga. Secy., J. R. Gray, Chamber of Commerce, Savannah, Ga.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION.
Apr. 22-25. Annual meeting at Waterloo, Iowa. Secy., H. E. Weeks, Tri-City Ry. & Light Cos., Davenport, Iowa.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 5-7. Annual meeting in Chicago, Ill. Secy., Franklin H. Wentworth, 87 Milk St., Boston, Mass.

AIR BRAKE ASSOCIATION.
May 5-8. Convention at Detroit, Mich. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
May 11-15. 34th Convention at Philadelphia, Penn. Secy., J. M. Diven, 47 State St., Troy, N. Y.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 18-21. 6th convention in Chicago, Ill. Secy., C. G. Hall, C. & E. I. R.R., 922 McCormick Bldg., Chicago, Ill.

MASTER BOILER MAKERS' ASSOCIATION.
May 25-28. Convention at Philadelphia, Penn. Secy., H. D. Vought, 95 Liberty St., New York City.

American Society of Engineering Contractors—The mid-summer convention will be held July 3-4 at Brighton Beach, L. I. The first day will be devoted to papers on general engineering construction, while the second will be devoted to papers on "Best Roads." The Secretary is J. R. Wemlinger, 11 Broadway, New York City.

Tri-State Water & Light Association of the Carolinas and Georgia—The fourth annual convention will be held at Atlanta, Ga., Apr. 16-17, with headquarters at the Piedmont Hotel. The program includes the following papers: "Accounting Systems for Water and Light Departments," by Joel Hunter, Atlanta; "Forestry and Water Resources," by H. S. Graves, Department of Agriculture, Washington, D. C.; "Water and its Purification for Industrial Purposes," by M. F. Corin, Philadelphia, Penn.; "Relation between Water and Fire Departments," by M. B. Sanders, Greenwood; "Relations between Boards of Health and Purification Plants," by F. A. Coward. A theater party and a number of interesting inspection trips have been planned. The chairman of the local entertainment committee is B. Frank Irwin.

Sixth National Conference on City Planning—The conference will be held at Toronto, May 25-27. The program includes the following papers: "Rapid Transit and the Auto Bus," John A. McCollum, Assistant Engineer, Board of Estimate and Apportionment, New York City; "Protecting Residential Districts," Lawrence Veiller, Secretary of the National Housing Association, New York City; "Toronto's Water-Front Development," R. S. Gourlay, Toronto Harbor Board. The Secretary is Flavel Shurtleff, 19 Congress St., Boston, Mass.

American Road Builders' Association—The next annual congress and exposition will be held in Chicago, Dec. 14-17, at the International Amphitheater. The Secretary is E. L. Powers, 150 Nassau St., New York City.

Engineers Society of Pennsylvania—The tenth anniversary of the founding of the Society was celebrated at the Club House in Harrisburg, on Mar. 31.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

of Engineering News, published weekly at New York, N. Y., required by the Act of August 24, 1912.
Editor, Charles Whiting Baker, New York, N. Y.
Business Manager, Frank B. Godley, New York, N. Y.
Publisher, Hill Publishing Company, New York, N. Y.
Owner, Hill Publishing Co., 505 Pearl St., New York, N. Y.
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C. W. Dibble, Vice-President,
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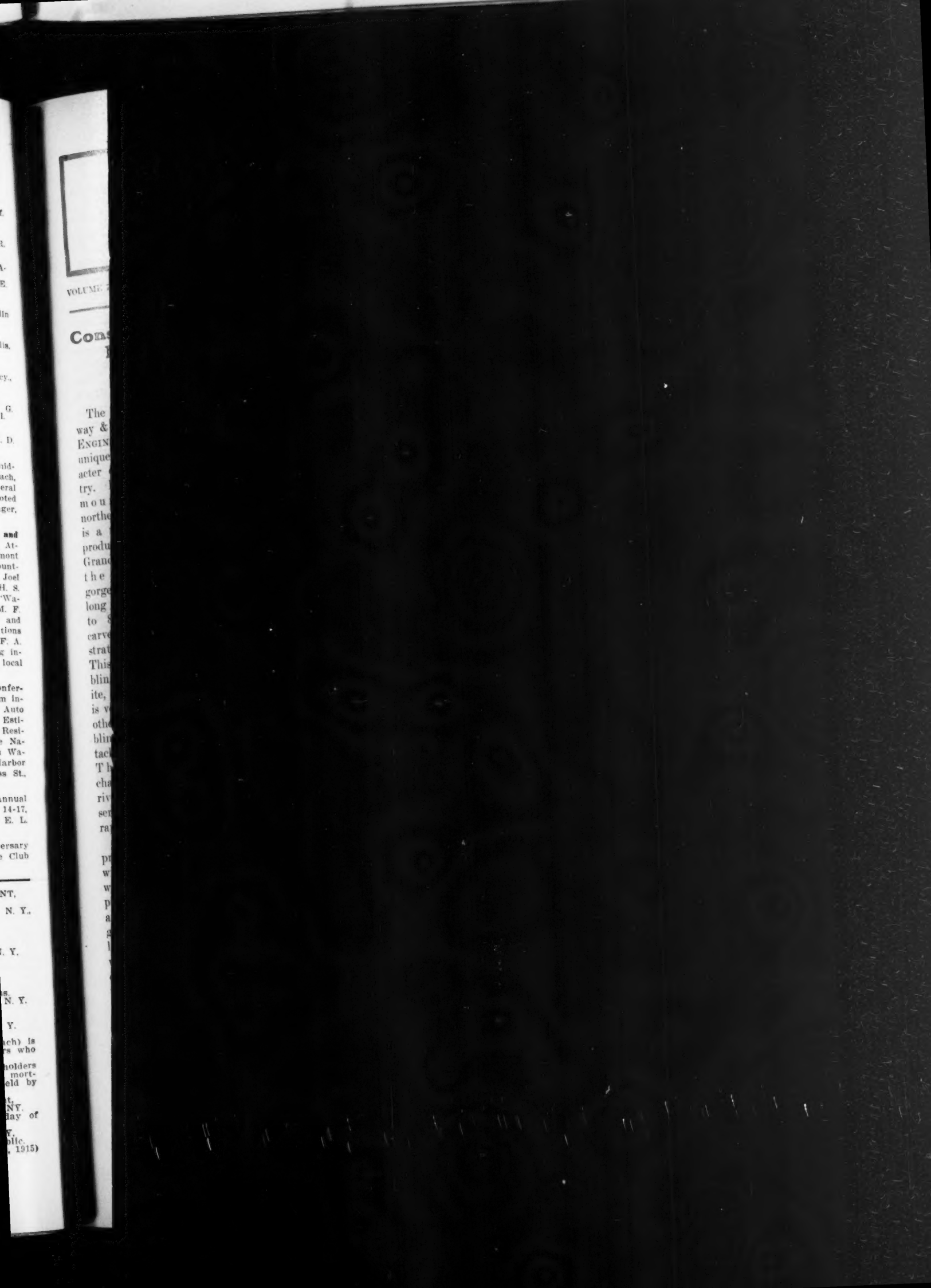
Sworn to and subscribed before me this 24th day of March, 1914.

RICHARD L. MURPHY,
Notary Public.
(My commission expires March 30, 1915)